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REPORT OF COMMITTEE ON GARBAGE DISPOSAL AND STREET CLEANING.

ROBERT HOFFMAN, *Chairman, Chief Engineer of Department of Public Service, Cleveland, O.*

Since the last printed report of the "Committee on Garbage Disposal and Street Cleaning" was published in 1911, no great changes in connection with these two subjects, so far as the fundamental methods of treatment are concerned, have taken place. The general methods and processes used in the disposal of garbage are the same as at the time of the 1911 report and no radical departure in street cleaning systems has occurred from those in vogue three years ago.

Improvements in the details of the work, in the organization of the departments having supervision, and in the appliances used, have of course been made from time to time. Of great importance is the apparently greater public recognition of the necessity of efficiency in the organization and administration of departments having these matters in charge.

Every progressive city makes some attempt to clean its streets and remove its garbage. The relative importance of these activities to the other municipal undertakings varies greatly among the various cities as does the proportionate expenditure for such purposes, depending largely upon the physical condition of the city, the character of its commercial life, the habits of its people, and the sanitary necessity. In many cases, however, the importance of these matters as shown in the appropriation for such purposes, depends largely upon local sentiment, or upon what can be conveniently spared

from needed expenditures for other matters without attempting any proper classification based on relative importance.

In order to materially assist in establishing some standard method of approaching the study of garbage disposal and street cleaning, a comprehensive report seems desirable. To make such a report on these two important subjects involves the securing and tabulating of a vast amount of information from which certain conclusions might be deduced, probably of great value to all interested. The following are some of the subjects which should be investigated:

Garbage Disposal.

1. Arguments for and against the various methods of treatment, such as reduction, incineration and destruction with heat utilization.
2. Number of cities utilizing each, and conditions which makes the system successful or otherwise, so if possible to determine whether under certain conditions some special method of treatment could be fixed upon as a standard method.
3. The obtaining of photographs, plans and description of good examples of each system.
4. Accurate data in reference to cost of installation and operation.
5. Recommendations regarding department or official under whose supervision and control the work should be conducted.
6. Data regarding methods and cost of collection.

Street Cleaning.

1. Limitations and conditions regarding the successful use of sweepers, flushers, block system, or other methods or appliances used in street cleaning.
2. Cost of appliances and expense of each method referred to some well defined unit.
3. Photographs and descriptions of appliances used in street cleaning.
4. Recommendations regarding the department or official under whose supervision the work should be conducted.
5. Amounts appropriated by various cities for street cleaning and the relative importance to other activities as expressed by the proportion of general expense appropriated for street cleaning.

6. Preferred form of department organization and different kinds of work which should be included under this heading of "Street Cleaning."

Several of the technical periodicals have published from time to time much of the information herein outlined as desirable, and several of the larger cities have on their own account made investigations and received data needed to determine these matters as they applied locally. There appears to be, however, no general comprehensive report published treating these two important subjects of street cleaning and garbage disposal in the manner suggested in the light of modern usage. A number of papers have been prepared and read before the American Society of Municipal Improvements, and several are to be read at this convention, all of which contain much of value, and may suffice to furnish all that the members require in this particular.

The committee has not undertaken to gather information relative to the foregoing items and it can be readily appreciated that to do so at all effectually would involve much work and expense. The query arises, in case it is thought of sufficient importance to the association to have such comprehensive report prepared, whether the work should not be subdivided by reference to sub-committees.

STREET CLEANING.

By Edward D. Very, *Sanitary Engineer, 17 Battery Place, New York City.*

Mr. Williston Fish, in an article describing his studies of the development of cities in his transportation investigations, states that there is an analogy between the evolution of cities and that of animal life. Both begin without circulatory tubes and gradually develop until in both there is an elaborate system for the transportation of foods, fuels and air. The development of means of communication, which in the city are called streets, marks the degree of progress of a community and at the present time attempts to raise the municipal standard find their fruition in the intensive studies of those engaged in the work of city planning.

When these avenues have been laid out, the next step is the construction of a form of surfacing which shall be the proper one to withstand the wear and tear of traffic. Then comes the duty of the street cleaner who has to do with the removal of the filth resulting from traffic conditions and the offal discarded by pedestrians.

The first pavement recorded in America, according to Tillson, was discovered by a farmer who, while plowing at Pemaquod, Maine, in 1625, found the point of his plow-share caught against a curb of a buried paved street. In New York the first pavement was laid in 1676, Boston about the same time, Philadelphia in 1719, Baltimore 1781, and Chicago in 1855.

It is a matter of surprise that while pavements were laid so long a time back, effective methods of cleaning were not considered until very lately and only just now have serious studies been made to solve the problem of efficient and economical street cleaning by competent men. This was in a

measure due to the fact that but recently have paving experts considered the cost of cleansing to be an item to be considered in the cost of maintenance of pavements. In the main, however, it was due to the fact that the cleansing operation was considered to be an elementary proposition and therefore not worthy of consideration in its details by technical men.

The work of street cleaning is in the majority of cities performed by a bureau of some department whose other activities are considered of greater importance and the men employed are usually those who would otherwise be on the rolls of the poormaster for relief because they have attained old age without having laid by sufficient means for their support and find themselves worthless as wage earners.

Up until 1882 this work in New York City was performed by a bureau of the Police Department and in that year there was instituted by legislative act, a department for the specific work of street cleaning and waste disposal. The first Commissioner, in 1889 after seven years endeavor to put the work on a proper basis, reported to the Mayor that he found his task an impossible one because he had only partial control of street conditions and because the appropriating bodies were unconvinced of the necessity to provide sufficient funds for the institution and operation of adequate systems of cleaning. In 1895 Col. George E. Waring, Jr., caused considerable merriment by taking the job of Street Cleaning Commissioner seriously and in attempting to apply engineering methods to the solution of the problems involved.

Col. Waring's studies were incomplete when his term expired, but he had arrived at the conclusion that the real problem of street cleaning was the removal of the fine dust, the removal of the other materials being without comparative difficulty. The fact is that the streets are cleaner today than ever, though this is not generally believed, but the fine dust problem has become more prominent in that the low-bodied fast-moving automobiles are raising and spreading the dust which before was not so raised and spread except by high

winds. Formerly ordinary traffic only raised and spread the dust to about the height of the infant in the perambulator and not until it was raised and blown into the faces of grown-ups was the knowledge of the continuous existence of this menace generally recognized.

In almost every large city we today find men of the calibre of Waring who are giving this matter of street cleaning serious consideration and who are applying to this work the principles of efficient and economical performance which obtain in other lines of business activity. Unfortunately the efficiency principle seems to be to get more work done for less money cost rather than better work done for the same cost with later endeavor to reduce the cost. The bookkeeper is the efficiency referee, whereas the practical operator observing practical results should be.

Then, too, the systems are founded on hand labor with machine auxiliary. In city development large street areas are being added annually and each city now may be described as "one of magnificent distances" with the result that systems must change to meet the new requirements and the basis of these should be machine work with hand labor as auxiliary.

New York has 2,173 miles of paved streets, Chicago 1,899, Philadelphia 1,371, and the other large cities have from 100 to 500 miles. As under average conditions a man can clean but about one-half mile per day, even could he perform the work with thoroughness the cost of such an army of labor for this work would be prohibitive. Machines at present used can do from two to four miles each and this work is done with a good degree of thoroness, making daily work on the same area unnecessary, and economical arrangement of mechanical plants may be made with good results. The man then merely polices the streets as a litter gatherer and can cover a very considerably larger route.

Some look to the automobile machine to increase the workable area, but I question if there is not a limit of speed wherein effective work may be done. The benefit to be derived by the

use of motor vehicles in my judgment will come rather from the ability to adapt better mechanical methods to the operation, thereby improving the quality of the work, rather than increasing the amount done per machine unit.

The machine broom as today operated leaves much to be desired, purely, I think, because the action of the broom is dependent upon the speed of traction whereas, should a motor vehicle be substituted, power may be transmitted to the axis of the broom independent of the tractive power of the machine, a proper rate of revolution of the broom may be found and maintained irrespective of the speed of progress of the machine. At present if you find a particularly filthy spot and endeavor to slow up to give it more careful attention, the speed of the broom lessens and the effect is lost, whereas were the power independent the result would be that required.

A mechanical device attached to the sweeping machine to pick up the stroke of sweepings from the broom and empty into a receptacle or receptacles would avoid a considerable amount of extra work now performed because the materials are spread by the wind or tracked by vehicle tires. Such machines are in evolution now but most of the devices are complicated or otherwise ill adapted to the performance of this work.

Flushing machines and squeegees are now constructed which do effective work but their adoption has been greatly retarded by the claims that the water has an adverse effect upon paving materials. Clifford Richardson, the asphalt expert, in his work on "The Modern Asphalt Pavement," says, "in a properly constructed pavement no important deterioration from water action should ensue within the life of the pavement, and, as a matter of fact, in the author's experience, the deterioration of asphalt surfaces laid under his supervision has in the last ten years become an item which is hardly worth consideration, where the form of construction has provided satisfactory drainage." As to the ill effects of water on the joints of stone and block pavements, tests made some years ago

in Detroit and Cleveland showed that such action was not necessarily adverse where good construction methods had been adopted. My judgment is that the paving engineer should design his exposed surfaces to resist water action for the great benefit to be derived from water cleansing. In flushing machines there is a distinct advantage in having an attached pump to express the water so as to get positive action continuously and on all the water which the storage tank may carry. A motor flushing machine has the advantage of carrying larger quantities of water with a consequent conservation of the time now lost in frequent filling of small tanks.

The machine squeegee or rubber scrubber is effective on smooth pavements where not too filthy, but the present method of delivery of water so close to the scrubber renders the work imperfect through the ineffective action of the water on the filth before the scrubbing action is applied. This may be remedied by preceding the squeege machines by a sprinkling cart sufficiently in advance to give the water action full effect. And here let me say that that sprinkling wagon should not be used, in my opinion, except as an adjunct to other cleansing devices, as by itself it is but a temporary makeshift and ineffective for good result. There is no reason for the filth removed by washing machines being deposited in sewer basins, but arrangements should be made for picking up the materials and carting them away as soon as they become sufficiently dry.

Dry cleaning machines are greatly to be desired and good progress is being made in the development of such. I know of two types of vacuum cleaners which are doing good work and need but little to make them practical and effective. These of course should be designed to pick up and place in receptacles the filth removed. When dry cleaning machine work is adopted there must still be periodical wet cleaning and such a combination should insure the best results. The system of cleansing must be so operated as not to interfere with the traffic conditions as the important factor of street use is for transportation. For this reason, in congested districts the machine work should be done at night.

Where I have proposed a system based on the foregoing lines, it has been said that such a system applies to large cities only, while I feel that it is a basis upon which a small city may start and develop as the city's needs grow.

My proposition then is: to district your city and arrange for periodic machine work so that machine units may be changed from one district to the other, avoiding unnecessary duplication of plant; make combinations of machine cleaning adapted to different requirements; use dry and wet methods alternately as necessity demands; have patrolmen work as litter gatherers where accumulations develop quickly which do not necessitate machine work; in congested districts or parts of districts do machine work at night and patrol work in the day time; do not employ old men on patrol, put them on park work or other less strenuous duty; keep cost data but do not regulate your work by that but by real efficiency; count cleansing necessities as items to be considered in the choice of pavements and on any type of pavement design to resist action of cleansing devices; and give serious and continuous study to the needs of this department of municipal activity. So may cleanliness be attained in city streets and health and comfort result.

DISCUSSION.

MR. OSBORN: Relative to preventing the material from going into the catchbasin, is it your opinion that it can be done where water is used in cleaning?

MR. VERY: Yes. You can control the force of the water so as to leave a window along the gutter, and you can put a portable screen in the basin inlet while you are doing the work, that will catch all the material that is coarse enough to do damage. That screen you can fold up and carry about. And as that fills up, the operator can throw the stuff back into the regular windrow. If you do it at night, and will wait for an hour or so of sun, the material will be dry so that you can take it up without leaving a bit.

MR. OSBORN: You think it more economical to remove it that way than from the catchbasin?

MR. VERY: Yes. The objection to letting it go into the catchbasin is the cost. Catchbasin material costs $1.50 a cubic yard, and the shoveling up of that windrow would cost but little.

MR. HANSON, of Champaign, Ill.: Has any thought been given to special designs of catchbasins to facilitate cleaning, where wet cleaning of streets is employed?

MR. VERY: Not to my knowledge. I have always felt it wasn't necessary to ask for a special design, because if you get a mechanical sweeper, you can take the stuff up very cheaply. There is no reason why this material should go in, except the little floating stuff which doesn't amount to anything. More material is put in the catchbasin by sweepers than by any machine used, because it is easier.

MR. HALLOCK: Do you know of any instance where a temporary dam has been used in front of the entrance to the catchbasin, such as a large rope?

MR. VERY: No, I do not think that is necessary, because the material should not arrive at the sewer.

MR. HALLOCK: But as a matter of fact, it does.

MR. VERY: That is a question of supervision. Let your driver drive a distance from the curb he is shooting at, and the power of the stream will die a certain distance from it. That is the edge of your windrow, and there is no power pushing back toward the basin. The stream should be more to the curb than forward.

MR. HALLOCK: That is all right in theory.

MR. VERY: I have seen it work out in practice, in St. Louis.

NOTE ON CLEANING AND MAINTENANCE OF PAVEMENTS WITHOUT SPRINKLING.

By WALTER F. SLADE, *Commissioner of Public Works, Providence, Rhode Island.*

The fact that bituminous pavements laid in the City of Providence are not sprinkled with water is a subject that has occasioned frequent comments on the part of visitors to this city who are interested in the maintenance and cleaning of such pavements.

I will say briefly that we are convinced that bituminous pavement maintained in good repair can be kept in a condition more satisfactory to all classes that travel the streets, both afoot and in vehicles, without, rather than with, using water for sprinkling.

We keep them clean by the patrol system, and reasonably free from dust. We believe that the use of water has an injurious effect upon the durability of the pavement. It emphasizes every slight depression and gathers and retains the fine particles that collect on a street, creating an unsightly appearance and a muddy, slippery condition. This results in the skidding of automobiles and a vast increase in the number of accidents.

By keeping the pavements free from water we escape another prolific source of complaint. Upon the best of pavements there will be depressions sufficient to retain a thin sheet of water. The rubber tires of the swiftly-moving auto, and especially the auto truck, will act as a syringe and force the muddy water in a small stream upon the clothing of any one passing along the sidewalk, and even across the sidewalk, covering windows and buildings with muddy spots.

That more might be learned upon the action of water as

affecting the durability of bituminous pavements, it would be instructive to bring out the results of laboratory tests, and a comparison of the condition of streets laid about the same time, where water was used and where not. The whole question is a subject worthy of the earnest consideration of all officers that have charge of the maintenance of bituminous pavements.

DISCUSSION BY GEORGE C. WARREN, BOSTON, MASS.

Commissioner Slade has presented one of the shortest and what to my mind, is one of the most important, comprehensive and useful papers which this convention has received in many years.

From seven years' practical trial the City of Providence has practically proved what I believe to be a fact, that street sprinkling, as it is quite generally practiced, is worse than a useless expense. In fact, I believe it to be a relic handed down from past generations and conditions. Providence, a city having a population of nearly, if not fully 200,000, has all kinds of street pavements and scarcely any city in the country has them in as uniformly good cleanly condition. Commissioner Slade tells us that this has been accomplished absolutely without sprinkling for seven years on all kinds of pavement, except that water-bound macadam is occasionally sprinkled with oil or oil emulsion. That is an object lesson which other municipalities will do well to emulate.

Fifteen years ago, when most of our street surfaces were macadam and dirt, and the comparatively few modern pavement surfaces were intercepted by macadam and dirt roads, and traffic entirely horse drawn, the sprinkling of pavements to keep down the dirt was essential. Since then there has been a rapid evolution until now much the greater percentage of traffic is motor drawn and with rubber tires, which make no dirt. The great majority of the pavement surfaces of our city streets now consist of some form of modern, nearly waterproof pave-

ment. And still we follow the old antiquated custom of keeping the little dirt wet down with street sprinklers, providing muddy, nasty surface which cannot be thoroughly cleaned and necessitates more sprinkling and more mud until the gutters become receptacles of mud and if the pavement surface ever gets dry, the hue and cry goes up, "Where is the sprinkling cart?"

We not only have the benefit of the seven years' experience of Providence but we have our country roads for an object lesson. Last week I took a 250 mile automobile ride over the bituminous surfaced country roads of Massachusetts, which have never been sprinkled and most of them never cleaned. There had been no rain for at least three weeks and I did not find a dirty road on the entire trip. A week before I had a similar experience over one hundred miles of bituminous road surface in Connecticut. This, notwithstanding that the country road surface is generally only 16 feet wide, with a similar width of dirt "shoulders" on either side, while our city streets are paved with a *naturally* clean surface from curb to curb. Why is this? It is simply because, without wetting down the dirt as fast as it forms and thus causing it to accumulate, as soon as an imperceptible dirt particle forms on the road surface it is picked up by the natural wind and rapidly moving automobile and thrown aside and in such small quantities that it is imperceptible and unnoticed and therefore does no harm.

Another important point is that if bituminous pavement surfaces are dry and clean the oil which drops from automobiles is quickly spread by auto tires to an extremely thin sheet which not only preserves the pavement surface but the slight amount of oil takes up the fine dust and materially helps to prevent the pavement surface from ever becoming dusty. If the pavement surface is wet these valuable effects of the slight dropping of oil from automobiles is entirely lost.

Of course in the case of city streets it is necessary, as Providence has done, to inaugurate a daily patrol system of street cleaning to pick up the horse-droppings before they can

become converted into dust, and to work around the intersections of unpaved streets, if any. Some one or more of the systems of pneumatic cleaning machines, now in the process of development, will surely soon be a practical success, but until then street washing at night is necessary under some conditions but not generally so. I believe that such a system of dry cleaning by hand patrol is less costly than the antiquated street sprinkling, supplemented by the street sweeper trying to do the impossible—thoroughly pick up the accumulation of mud. Even if dry cleaning were not cheaper its greater efficiency in keeping street surfaces in better condition for use by automobiles, horse and foot passengers, merits its adoption, to say nothing of the far greater durability of all forms of street pavement surfaces when dry than when wet. It is generally conceded that water is the worst enemy of pavement surfaces. When the water is applied in the form of wetting down an accumulation of dirt subjected to steel tire traffic, we have the condition which from all ages has been known to wear the hardest steel and is therefore used in the grindstone and for sawing stone, to-wit: the application of mud under a grinding process.

While some forms of pavement are doubtless more affected by water and mud than others it injuriously affects all classes of pavement, and I will not except stone, even granite blocks, the wearing of which to a "turtle back" surface I believe to be primarily due to slight absorption of water.

I believe that repairs required to all classes of pavement are more generally the result of wetting down the dirt, leaving the surface in a continually more or less muddy condition than by the traffic, or rather what would be the traffic under dry, cleanly conditions. A city or street in or on which sprinkling or other method of continual wetting of the pavement surface has not been practiced is almost universally one where the pavements are the best of their kind, no matter what form of pavement construction is used.

Washington, D. C., has the enviable reputation of having

the most durable pavements of all kinds. For many years the system of cleaning in Washington has been hand patrol without sprinkling, except a very light sprinkling—just enough to lay the dust but never to convert into mud—immediately in advance of the night sweeping.

Fifth avenue, New York, is always dry, except during rains, and we find one of the most durable asphalt pavements in the world. Fifth avenue provides an excellent single example of the lack of the necessity of sprinkling any street however much traffic it carries. The traffic on this avenue is so concentrated that it would be impracticable to run sprinkling wagons over it even if the city desired to do so and yet the pavement is always clean and never dusty.

A simple object lesson is the fact that when contrary to a practice of keeping pavement surfaces continually wet down by sprinkling wagons, a portion of the surface has become dry for a time it is found to be clean while the still wet portions of the surface are still covered with a nasty, slimy, slippery mud.

The asphalt pavement on Alexander street, Rochester, in the laying of which I was plant foreman, in 1884 and 1885, is still in existence and has a record for low cost of repairs, which has been repeatedly referred to in reports of this association, has until quite recently been free from street sprinkling. I was in Rochester about ten days ago and found the sprinkling cart had gotten in its work on Alexander street and it is now rapidly deteriorating. Butger street, Utica, laid in 1886, has been through a similar experience of no sprinkling. Michigan boulevard, Chicago, from Jackson Boulevard to Tenth street, paved partly with creosoted wood blocks and partly with asphalt, was always in dry condition and carried a very heavy traffic for ten years and was in good condition, when about four years ago it was removed on account of widening the street, necessitated by the great increase in volume of traffic.

The bituminous pavement on Michigan avenue, Chicago, is

now nearly five (5) miles long. By actual count on July 26, 1912, it then carried a daily traffic of 11,425 vehicles which has probably now increased to at least 14,000 vehicles per day. The pavement surface is always clean and never cleaned or sprinkled other than patrol cleaning except as to narrow strips, about four feet wide, which are sprinkled and hand broomed at night to remove the slight dirt which naturally collects near the curb. Other boulevards in Chicago are similarly treated and confirm what is said above regarding New York City and further confirm the experience of Providence and the statement made above that a modern pavement surface requires little cleaning and will always be clean if it is only kept dry and hand patrolled through the day.

I hope the day is not far distant when our cities generally will adopt a modern system of street cleaning without sprinkling, following the recent revolution from dirt streets to modern pavements and from horse drawn to motor traffic. Providence has led the way. Other cities will do well to follow.

The cleaning effect of automobiles above referred to is doubtless accounted for by the combination of speed of the automobile and the current of air thrown on the pavement surface by the engine exhaust. Consequently in connection with a system of hand patrol a street pavement surface in reasonably smooth condition never gets dirty, or at worst never gets so dirty that it cannot be cleaned at night without sprinkling during the day.

COSTS OF COLLECTING, HAULING, TRANSFERRING AND TRANSPORTING REFUSE MATERIALS.

By Samuel A. Greeley, *Winnetka, Ill.*

A very important element in the collection, haul, transfer and transportation of refuse materials is the cost. Many local factors enter into the cost element, and unless these are considered and understood, the cost data are misleading. Standard forms for recording cost data of refuse collection are not used extensively, so that the data presented should not be taken without qualification. In all cases, reference should be made—if possible—to the original source of the information. Methods of analyzing the cost of various parts of the service are given, followed by actual cost data.

Elements of Cost.

The elements of the cost of each part of the collection service can be segregated and studied advantageously by the following method. The unit quantities used in the computations were assumed for certain local conditions and will not necessarily apply everywhere. They are presented here to illustrate the method of analysis.

Loading—The cost of loading will vary with the character of the material, the district served, the season of the year, the unit cost for labor in each locality and other local conditions. The method for loading garbage follows:

a—Number of people per house or per collection made	10
b—Number of minutes required to make one collection or to give service to ten people	1
c—Interval in days between collections	2
d—Capacity of garbage wagons in tons	2
e—Quantity of garbage produced in tons per 1,000 population per day	0.273

f—Quantity of garbage after two days' interval between collections, tons per 1,000 population per day 0.546

g—To make collections from 1,000 people requires 100 collections, taking 100 minutes time.

h—Time in minutes required to load a wagon with two tons of garbage in accordance with the date above equals $\frac{2}{0.546} \times 100$ .... 367.

i—The time required for loading is thus 6.1 hours. If the cost of the team, wagon and collector be taken at 75 cents per hour, the cost for loading one two-ton wagon will be $4.57, and the cost per ton for loading garbage ($2.28) 2.28

The analysis can be applied to the loading of ashes, rubbish, mixed refuse or any refuse material, if the proper unit quantities and basic data be first determined. The cost per ton for loading other refuse materials in accordance with assumed data will be as follows:

Materials.	Cost of Loading Per Ton
Ashes	$0.415
Rubbish	2.62
Mixed refuse	0.56

Motor Trucks—The cost of loading a motor truck can be studied in a similar way. The cost of operation will be greater per hour and the rate of loading will have to be increased proportionately to make the cost comparable with loading a team drawn wagon. The cost of haul by motor truck will be less.

The use of motor trucks in refuse collection service will increase. A relatively high loading cost can be reduced by limiting the motor truck to transportation after the loading of the wagons by the so-called traction and trailer system now being tried on a large scale in New York City and used in quite a number of European cities.

Hauling—The refuse material loaded in the collection wagon must be hauled to the transfer station or place for final disposal. This will be done by horse drawn vehicle or by motor. The length of haul will be from the point of last col-

lection to the place of final delivery. This distance or haul must be covered twice for each complete load.

The cost of haul will depend on the rate of travel, the weight of the load and the cost of the team and the driver, or motor and mechanic. The cost of team haul may be analyzed as follows:

ASSUMED:

Rate of travel	3.0	miles per hour
Cost of outfit	$0.75	" "
Cost per mile travel	0.25	" "
Cost per mile haul	0.50	" "
Cost per ton—mile haul with a two-ton load	0.25	" "

The cost of haul by gasoline or motor truck may be analyzed as follows:

ASSUMED:

Rate of travel	6.0	miles per hour
Cost of outfit	$2.40	" "
Cost per mile travel	0.40	" "
Cost per mile haul	0.80	" "
Cost per ton—mile haul with a five-ton load	0.16	" "

The rate of travel will vary considerably from different sections of a large city, being slower through streets congested with a large volume of traffic. In such districts, collection work should be done at night or during the early morning hours.

Transfer Stations—The operation of transfer stations should also be considered as a part of the cost of transportation. A transfer station to handle 600 cubic yards a day or 375 tons may cost, depending upon type of building and local conditions, about $50,000.00, including land in a fairly well-built up section.

The annual cost of operation may be estimated as follows:

Interest at 5 per cent	$2,500.00
Depreciation of plant	1,250.00
Labor—	
1 Foreman	1,200.00
4 Laborers	3,600.00
Repairs and supplies	2,500.00
Total	$10,800.00

This is equivalent to a cost of 9.4 cents per ton.

The cost of transportation of refuse from the transfer station to the place of final disposal depends upon the method used. The cost for several methods is discussed below.

Trolley Transportation—Assume a typical transfer station receiving 600 yards of refuse material per day. Assume trains to be made up of one motor car which carries no load and two trailers. Assume each trailer to have a capacity of 25 cubic yards. To move 600 cubic yards, 24 trailer loads are required. If the place of disposal be so located that each train can make two trips a day, six trains will be required. Assume that three motors can handle the six trains. The daily cost of operation will then be:

Motor cost, three at	\$25.00=\$75.00	per day
Trailers, twelve at	6.00= 72.00	" "
Total	\$147.00	

If the 600 cubic yards of refuse weighs 375 tons, the cost of trolley transportation will be 40 cents per ton.

Barge Transportation—A good serviceable tug will cost about \$30,000.00 and deck scows about \$7,000.00 apiece. The annual cost of operating a fleet may be as follows:

Annual cost of tug—		
Interest at 5 per cent		\$1,500.00
Depreciation on 15-year life		1,389.00
Labor—		
Captain	\$2,100.00	
Engineer	1,800.00	
Fireman	1,000.00	
Deckhands	1,800.00	
		6,700.00
Repairs		2,500.00
Fuel		3,500.00
Supplies		1,000.00
Insurance		200.00
Total		\$16,789.00

Annual cost of barge—

Interest at 5 per cent	$350.00	
Depreciation	324.00	
Deckhands	1,800.00	
	$2,474.00	
Assume that 1 tug serves 4 barges		$9,896.00
Total annual cost of fleet		$26,685.00

If each barge makes one trip per day, carrying 100 tons of refuse, the cost per ton amounts to 22 cents.

In like manner the elements of cost can be determined for other methods of transportation.

Steam Railroad Transportation—The cost of transportation by steam railroads depends principally upon the switching charge. These will range from $5.00 to $15.00 per car. A car will hold about 40 tons of garbage, so that the switching charge will average about 20 cents per ton.

Available Collections Cost—Actual cost data should be studied to check the costs estimated above, but these are not available for a large number of cities. The costs for collection service are generally recorded to include both loading and hauling in one figure, while costs of transportation are frequently given separately. The cost data for some cities in which the itemized cost of collection is available have been summarized in the following table:

COSTS OF COLLECTION (LOADING AND TEAM HAUL) FOR REFUSE MATERIALS, 1914.

CITY	Year	Population Served	Total Annual Cost	Total Annual Tonnage	Total Annual Yardage	Unit Cost Per Ton	Unit Cost Per Yard	Cost per Capita	References
Garbage—									
Boston	1913	480,000	$131,648.40	54,215	....	$2.93	.....	$0.27	Annual Report
Chicago	1912	2,300,000	381,174.00	119,159	....	3.20	.....	0.17	Civil Service Commission
Cleveland	1912	596,400	127,800.24	43,555	....	2.93	.....	0.21	Annual Report
Columbus	1912	192,700	34,779.23	18,789	....	1.85	.....	0.18	Annual Report
Dayton	1908	110,300	21,000.00	9,941	13,479	2.11	1.56	0.19	Annual Report
Detroit	1910	465,766	66,865.67	34,065	....	1.96	.....	0.15	Annual Report
Evanston	1910	24,978	3,186.00	2,800	4,670	1.14	0.68	0.13	Annual Report
New York	1910	4,406,000	275,380.00	336,984	....	0.82	.....	0.06	Annual Report
Winnipeg	1911	151,918	19,371.90	15,510	....	1.25	.....	0.13	Annual Report
Ashes—									
Boston	1913	480,000	346,396.01	247,208	....	1.40	.....	0.73	Annual Report
Evanston	1910	24,978	2,174.00	....	13,461	.....	0.16	0.09	Annual Report
Winnipeg	1911	151,958	5,793.73	5,227	....	1.11	.....	0.04	Annual Report
Rubbish—									
Columbus	1912	192,700	47,887.12	....	75,096	.....	0.64	0.25	Annual Report
Evanston	1910	24,978	5,108.00	....	29,479	.....	0.17	0.21	Annual Report
Ashes and Rubbish—									
Cleveland	1909	543,000	119,982.00	84,547	202,752	1.42	0.59	0.22	Annual Report
Cincinnati	1909	360,000	116,631.68	87,611	222,634	1.33	0.52	0.32	Annual Report

Chicago Data—Jacobs & Senfield have made a careful analysis of the cost of collecting garbage, and ashes, and rubbish in Chicago. This data is compiled in excellent detail and accuracy. The average costs for the five years—1908 to 1912—are given below:

TABLE—AVERAGE COST OF REFUSE COLLECTION, CHICAGO, ILL.
(Loading and Hauling.)

Year.	Cost Per Ton of Garbage.	Cost Per Cu. Yd. Ashes and Rubbish.
1908	$3.78	$0.56
1909	3.76	0.57
1910	3.43	0.59
1911	3.19	0.62
1912	3.20	0.60

If ashes and rubbish together weigh 1,000 pounds per cubic yard, the cost of collection per ton amounts to $1.20.

IMPROVED METHODS FOR RECORDING COST DATA.

The value of unit cost data for loading, hauling, transferring and transporting refuse materials should be realized by city officials. Accurate records should be kept and published in similar forms in different cities, so that comparisons can be made and a check secured on the efficiency of the local work. The total costs should be divided and recorded in accordance with the details discussed to show the cost of each element of the work.

HIGH TEMPERATURE INCINERATING PLANT AT SAVANNAH, GA.

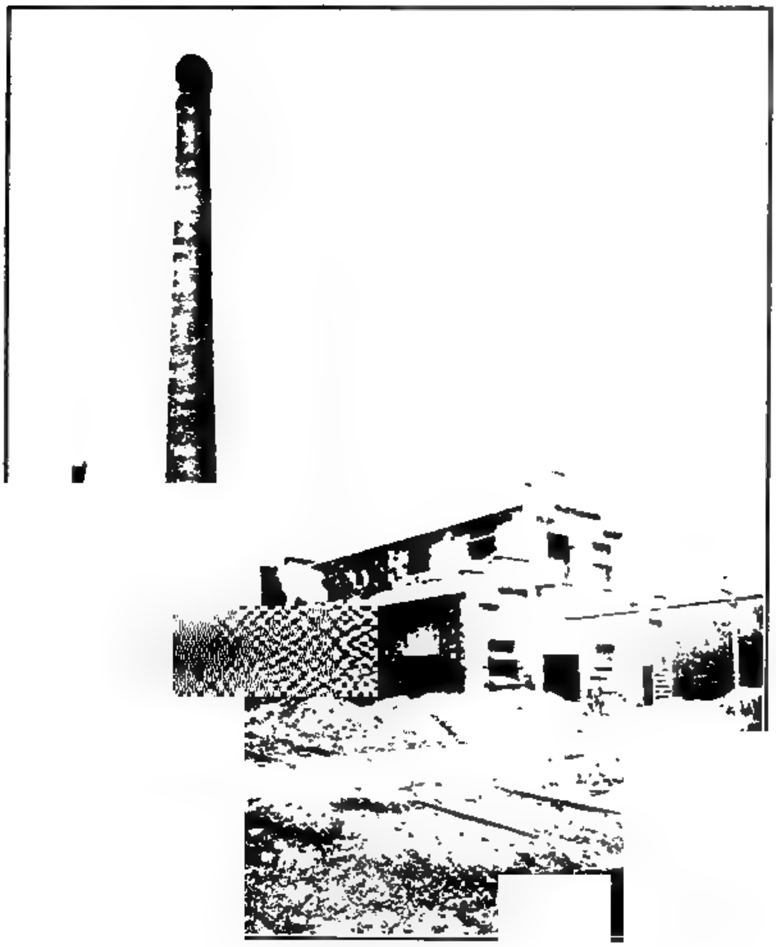
By E. R. Conant, *City Engineer.*

Refuse disposal by the incineration system has been adopted in a number of American cities. It is possible, however, that some of you have not been called upon to make a special study of refuse disposal by the above method, and before describing the plant at Savannah it may be of interest to you for me to briefly refer to this method of refuse disposal and to particularly give the meaning of the term High Temperature Incinerator.

The earlier plants for destroying refuse by fire were low temperature plants, and these plants were very crude. The earliest plant, of which there is record, was constructed in 1860, in London. They were not adopted to any extent until 1876, and between that year and 1885 many improvements were made, but in all cases the plants required secondary fume or fire boxes to furnish auxiliary heat to destroy the gases coming from the burning refuse. The refuse was burned at a comparatively low temperature on specially designed grates and the heat was insufficient to evaporate water and raise steam in boilers so that power could not be developed and used to give force draft. The result was that more or less unconsumed smoke and odor passed from the stack. The earliest installation in the United States of low temperature plants, of any importance, was in 1886, and these plants were generally termed crematories; however, this term was erroneously used, for strictly speaking the word implies the burning of garbage at high temperatures.

Little by little improvements were made until the low temperature plants merged into high temperature or incinerating plants. With the high temperature incinerators the refuse consisting of garbage, rubbish, street sweepings, paper, etc., is generally emptied together into a storage hopper and is then

taken from the pit to the furnaces. The dry material is intermixed with the wet and the mixture placed on the grates has in same sufficient fuel for the combustion of the total mass, force draft being used to aid the combustion and giving a high temperature. The gases from the furnace enter a combustion chamber, where the temperature ranges from 1,500 to 2,500 degrees F. No auxiliary grates such as are used in low tem-



The Savannah Destructor. Steam pipe in right foreground leading from destructor to pumping station.

perature plants are necessary. No stench fires are needed to kill the odors. The ash from the refuse is largely fused on the grates into a vitrified clinker, which is free from organic or germ life. The installation of high temperature destructors in America, of which there have been about twenty-five installations since 1906, has brought up the problem of what to do with the large amount of waste heat that is derived from the incineration of the refuse. In most cases the difficulty of finding a way to utilize this heat has resulted in a continual waste of the by-product steam generated in boilers heated by the hot air coming from the combustion chamber.

The plant at Savannah is unique, in that all of the steam generated by the heat from the furnaces is used commercially, and perhaps it is the only plant so far constructed in the States that uses the by-product steam to its full extent, without use of auxiliary fuel. The design for the construction of high temperature destructors or incinerators requires careful thought and study, due largely to the fact that the nature of the refuse varies so greatly in different cities, and further the refuse collected varies at different seasons of the year in the same city. In a southern city during the winter the refuse collected is to a large percentage dry combustible material with a moderate amount of ash. For a portion of the summer the amount of garbage collected increases during the melon and vegetable season and this type of extra garbage contains a great amount of moisture.

Savannah's population within the corporate limits of the city is about 80,000, of which 40 per cent. is colored and 60 per cent. white and it may be classed as a residential city. The city has about 48 miles of paved streets and lanes. The city is laid regularly and has a complete system of lanes, so that deliveries and collections to households can be made in same. The area of the city within the corporate limits is approximately seven miles, and the area of the thickly populated section is about half this area. Savannah being a southern city it might be expected that the people would use fresh

vegetables almost entirely, but to my surprise, it is found that a large amount of prepared food is consumed, as is shown by the large amount of tin cans found in the clinker taken from the furnaces. During July and August there is a large consumption of watermelons and cantaloupes. By actual weight the daily amount of melon and cantaloupe rinds collected for the above two months of this year averaged over 20 tons.

The Savannah Destructor from the other end. The water works pumping station in the background.

During this period when a great amount of vegetable matter is collected the percentage in weight of strictly garbage amounts to approximately 55 per cent. Household ash and stable sweepings is only 5 per cent. or less. The remaining 40 per cent. consists of rubbish. During the remainder of the year the percentage of garbage in weight is much less, varying from 40 to 45 per cent. In winter the percentage of household ash is not over 10 per cent. if that. It will be seen from the above that for a portion of the year the refuse that is con-

sumed contains a great amount of moisture, and for the greater portion of the year the composition of same is comparatively dry. In the design for a destructor plant for this city this variable class of refuse had to be considered and a design perfected that would be suitable for the varying existing conditions.

Savannah enjoys a daily collection of garbage and rubbish, other than Sundays, for the greater portion of the populated section of the city. The outskirts receive a collection every other day. On Sunday a collection is made at the hotels, restaurants and boarding houses. Household ashes are collected, but cinders from the manufacturing plants are not collected by the city. In the past the collection of household ash has been separate from the collection of rubbish, but in future there will be a compound collection. Night soil is collected under contract and taken outside of the city. Collection from catch basins is taken to the dump. Dead animals, manure from the city stables and street sweepings from the paved streets, while collected by the city are sold to private parties, so that none of the above are taken to the destructor plant.

Since July 1, 1914, all of the refuse collected has been weighed, and the total amount collected for the nine months amounted to 18,033 tons. This consists of the household, hotel and restaurants' garbage and rubbish, paper and rubbish from stores, receptacles on streets and a certain amount of household ash. The greater proportion of ash that has been collected from households has in the past been used in filling low places in sand streets. The mean daily collection varied from 54 tons in March to approximately 100 tons in July. The cost per ton for collection was $2.29. This includes labor, care of stock, repairs to carts and harness and the purchase of small tools used for collection.

In 1891 a crematory of the low temperature type was constructed which was unsatisfactory and was only operated for a few years. From 1902 up to the completion of the present destructor plant in March, 1914, the disposal of the city's

waste was by dumping same on waste land about four miles from the city. This method was unsanitary and objectionable.

Early in 1913 the writer studied the various methods of disposal of garbage and visited several cities where high temperature incinerator and reduction plants were in operation,

Dumping refuse from wagon into storage hopper.

and after giving due weight to the various methods, recommended to the city the adoption of a high temperature incinerator plant, which recommendation was approved by the mayor and aldermen and proposals were asked. After carefully considering the proposals received a contract was made and entered into in July, 1913, with the Destructor Company of New York for a plant of the Heenan type with a daily capacity of 130 tons.

The company made two proposals; one to furnish a destructor plant operated wholly mechanically with clinker

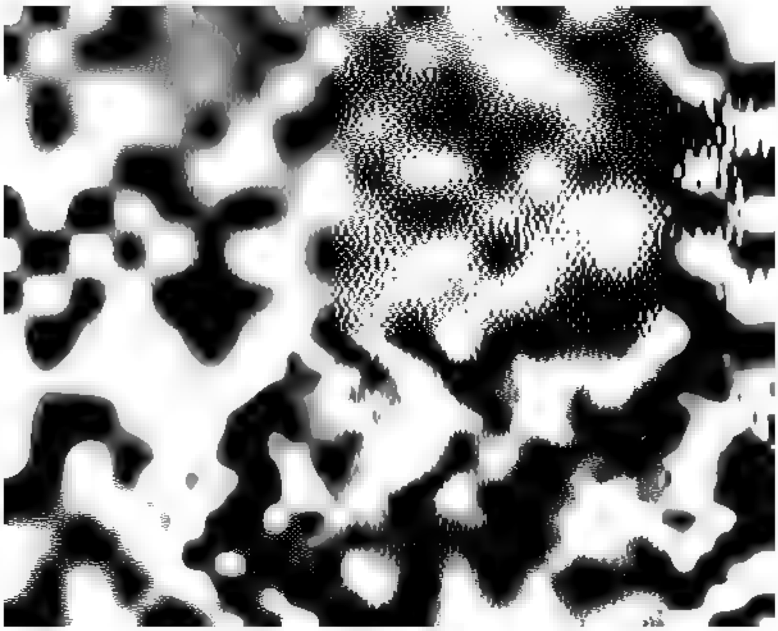
chamber under the grate at a cost of $170,000.00. The other proposal was to furnish a plant of the same general type at a cost of $125,000.00 with a different method of charging the furnaces and withdrawing the clinkers. With the higher priced plant the guaranteed cost of operation was 29.30 cents per ton; with the lower cost plant 40.4 cents per ton. The guaranteed water evaporation for the $170,000.00 proposal was 1.8 pounds of water to one pound of refuse consumed; for the $125,000.00 plant it was 1.34 pounds of water to one pound of refuse consumed.

While the guarantees for the higher priced plant were inviting, the writer for good reasons recommended the second or lower priced proposal to be adopted by the city, and from results attained it would appear that the selection was the best. In considering the adoption of the high temperature plant, consideration was given to making use of all by-product steam that could be obtained by the burning of the refuse over that required by the plant for operating the plant to partially operate one of the city's water works pumping stations.

With this in view the plant was located on the city's property and adjacent to the pumping station. The distance between the buildings as constructed is but 60 feet, and the distance between the boilers of the destructor plant and where the steam is delivered to the main steam header in the boiler room of the water works is 140 feet.

In the destructor plant there are two 65-tons-capacity-per-day Heenan type furnaces. Each unit comprises four cells about 28 inches wide on the bottom, 34 inches at the top, 16 inches deep, 8 feet long. Each unit has a separate charge combustion chamber, a 200-horsepower Wicks water boiler and an air heater and cylindrical centrifugal fan for supplying forced draft. The cells are fitted with trough grates, which is a comparatively recent development, but is already quite extensively used in plants constructed by this company and by Heenan-Froude, Ltd., Manchester, Eng., who made the original design. The contract also covers a building to house

the plant, a receiving pit of 260 cubic yards capacity for receiving the refuse, a regenerator or preheater, electric hoist for taking the material from the storage pit and transferring it to the containers, necessary instruments for measuring and recording condition of the furnaces, wagon scale for weighing the refuse, a steam turbo or engine-driven generator of 75



Grab-buckets dumping refuse into containers above the furnace cells.

kw. for supplying the necessary current for lighting the plant and operating the motor. The cells were so constructed as to have a burning area over each grate of 20 square feet, each boiler to have a heating surface of 2,000 square feet with a working pressure of 160 pounds per square inch. The stack, of radial brick construction, is 150 feet high and 6½ feet inside diameter at the top. The receiving storage pit as constructed in this plant has advantages over some that have been observed at other plants. It is 32 feet long, 20 feet deep and 11 feet wide. The greatest length is parallel with the beam

supporting the crane carrying the hoisting grab bucket, and the bucket can reach any of the material in the pit by direct drop, without extra rehandling in the pit. Then again, the bucket can pick up any portion of the refuse dumped in the hopper and distribute it over the surface, if desired, to bring about a better mixture. The combustion chamber is of ample capacity and properly proportioned to receive and thoroughly mix and burn all gases coming from the different cells discharging into it. There is ample space for the collection of dust in the chambers and a door to same is large enough to permit the entrance of dead animals.

A superheater, of the Foster type, superheats the steam generator by the boiler. The air heater is located immediately at the rear of the boiler. The supply of air for forced draft is taken from the ventilating system within the building. The containers into which the material is deposited from the grab bucket are arranged one over each cell of the furnaces. Each has a capacity of about one cubic yard and they are closed by horizontal sliding doors built in two parts. Each cell receives charges of about one cubic yard. The space above each grate is common to each cell and to the combustion chamber so that there is free interchange of heat between cells. The main grates on which the combustion take place are of heavy cast iron construction. They are perforated with a sufficient number of holes arranged to give proper distribution of air throughout the refuse and at the same time to secure the maximum cooling effect on the iron supports. The clinker car is of special design for receiving clinker as it is withdrawn from the furnaces.

Guarantees Made.

The plant shall be capable of destroying in normal operation without additional fuel 130 tons of refuse in 24 hours. No odors or obnoxious gases shall escape from the chimney or the building. That at no time during the normal operation of the plant shall the temperature fall below 1,250 de-

grees F., and that an average temperature of 1,500 degrees F. shall be maintained in the combustion chambers. That the number of pounds of steam generated in the boiler from and at 212 degrees F. per pound of refuse consumed shall not be less than 1.3 pounds per pound of refuse consumed. That the net effective boiler capacity in horse power for steam utilization over and above that required for operating the plant will be 330 horse power, based on 34.5 pounds per boiler horse

Stoking refuse on grates.

power. The cost per ton for the incineration based upon the schedule of wages to be paid and with force as required and set out in the specification shall not exceed 40.4 cents per pound. Another important guarantee is as to the number of pounds of refuse to be burned per hour per square foot of grate area upon which final combustion takes place. In this plant it is guaranteed not to be less than 68 pounds, which is a reasonable guarantee.

Total Cost of Plant.

Some changes were made in the proposal received for the plant, and the contract with the destructor people excluding the extras was $120,000.00. Extras for excavation, concrete foundations, steam line from plant to pumping station, etc., paid contractor were $3,971.00. Cost of inspection and miscellaneous work done by city forces in connection with the construction of the plant was $2,300.00, making the total cost of the plant to the city $126,271.00.

Method of Operation.

Refuse brought to the plant is first weighed on wagon scales, and is then dumped into the storage hopper at the ground level. The refuse is fairly well mixed and from there it is taken from the grab bucket operated by an electric transporter and delivered to the containers that are located over each cell of the furnaces. At the bottom of these containers is a solid door operated by hydraulic power, so arranged to be convenient to the stoking floor, which enables the stoker to fill his grate in accordance with the requirements of his fire. Stokering is done through a supplementary door, which avoids the necessity of opening the large door through which the clinker is withdrawn.

The clinker formed on the grates is removed by semi-mechanical means. The sides of the grates diverge slightly from the rear to the stoking door. There is a large bar to which is fastened a plate which forms an upturned hoe laid on the bottom of the grate before the first charge is dropped upon it, and the clinker is pulled out bodily by power obtained from an hydraulically driven winch on to a hand-pushed car, which is pulled over a level paved surface to the dump. This method of clinkering permits of the clinker being removed from the grate in from three to four minutes. The platform at the dump is on the same level as the stoking floor and the clinker is dropped over a vertical wall and is then loaded in carts and hauled to low undeveloped land a few hundred feet

distance. While withdrawing the clinker, regulating valves are operated so as to shut off the air supply coming from the air heater.

One great advantage of the furnaces at this plant over the furnaces constructed at many other plants is that a deep fire is maintained, which enables the wet portion of the refuse to be more thoroughly dried and destroyed than in shallow grates. In my opinion the success of this plant is partly due to this particular feature.

Clinker drawn by mechanical means into clinker car for removal from furnace.

The average time of burning charge is 20 minutes. Usually six charges are made for each clinker produced on the grates. When the plant is working at its full or nearly full capacity the labor required is operated in three shifts of eight hours each. With the destruction of from 60 to 75 tons of garbage only one unit is used with three shifts of labor. This is better than to use two shifts, working both furnaces, for a more even supply of steam is delivered to the pumping station.

During July and August when the delivery of watermelon rinds and other vegetable matter delivered to the plant averaged 20 tons daily, of course this amount of extra wet garbage, bringing the percentage of garbage above the guarantee, was only destroyed by adding dry material that had sufficient heat units in same to offset the successive moisture in the garbage. This was brought about by adding about 10 per cent. in weight of cinders collected from manufacturing plants. With the addition of these cinders complete combustion of the garbage was obtained. The extra cost of the cinders was only the cost of drayage from the plants to the destructor plant.

From the day the plant commenced to consume the garbage on March 24, 1914, to the present date, all of the refuse delivered to the plant has been consumed and none had to be hauled away. The amount saved in fuel at the water works plant from March 23rd to October 1st was a little over $3,000.00, or approximately $500.00 per month. Some changes have been made whereby there will be considerable increase in the amount of fuel saved and it is anticipated that from now on the saving will amount to about $600.00 per month. If the refuse delivered to the plant equals the capacity of the plant, sufficient steam will be furnished to operate the pumping station entirely and a saving of approximately $12,000.00 would ensue to the city.

The pumping station has two ten-million-gallon duplex compound Holly-Gaskill pumping engines and two cross-compound air compressors all of which are operated condensing. The steam pressure carried at the water works plant is 90 pounds, but at the destructor plant is carried up to 150 pounds with 100 degrees superheat. The pressure, however, is reduced by passing through a reducing valve on the main steam header in the boiler room of the water works.

Cost of Operation.

The total amount of refuse consumed from March 24th, when the plant was completed, to September 30th, was 14,364

tons. The cost of operating the plant was $8,190.00 and there should be added salary of weighman amounting to $428.00, and a laborer at the pit supervising the dumping of the cars, amounting to $370.00, making a total cost for destroying the garbage $8,988.00, or a cost per ton of 62½ cents. Allowing for the saving of fuel at the pumping station for this period the net cost for destroying the refuse was 41.6 cents.

The percentage of clinker obtained from destroying the refuse varies from 20 to 30 per cent. of the total of refuse burnt. During the season when the refuse is dry the weight of the clinkers is from 20 to 25 per cent. During July and August this varies from 25 to 30 per cent. It will be seen from the above that the unit cost of destroying the refuse was higher than the guaranteed cost, but it must be borne in mind that the guaranteed price is based upon the plant working at its full capacity, for then the amount of labor would be practically the same as when one-half of this amount was being consumed.

The cost of destroying the refuse, the amount of evaporation of water and steam obtained is based on the refuse having the following percentages of material:

45 per cent. garbage.
40 per cent. rubbish.
10 per cent. ash or cinder.
5 per cent. manure by weight.

The garbage to consist of organic material, vegetable and animal with water and grease; rubbish to consist of paper, rags, excelsior, straw, glass, etc.

Labor.

Labor for each shift. One man to feed hoppers, four stokers, one engineer, one craneman and one man per watch, making total labor charges per watch $17.50, or $52.50 per day of twenty-four hours. This, however, is not expected to be adhered to, and with the amount of refuse to be destroyed less than 130 tons daily the cost of labor will be considerably reduced.

TESTS.

On June 4, 1914, a trial test lasting eight hours was made with a running start. The refuse was selected so as to comply with the specifications by which the contract is expected to be carried out. Sufficient steam was furnished to the water works during the twelve hours to operate entirely the plant, which would indicate a saving of coal at the rate of about $1,000.00 per month. The total refuse burned was 86,666 pounds. The actual duration of the test was 7 hours and 35 minutes, making the consumption somewhat above the guarantee. The total refuse burned per square foot of grate surface was 72.25 pounds, whereas the contractor's guarantee was 68 pounds. The average temperature of the combustion chamber during this test was 2,100 degrees, the guarantee being 1,500 degrees. The total water evaporated for compound refuse was 1.53 pounds, against 1.3 pounds, the guarantee. The estimated horse power in operating the plant was 118, the excess horse power being 452. The total number of charges made for both furnaces was 166. The number of times clinkers were drawn from both chambers was 26.

On June 25, 1914, a twenty-four-hour test was made, the actual duration of same being 23 hours and 15 minutes. The type of refuse destroyed was that guaranteed by the contractors to fulfill their contract. The total refuse per square foot per grate surface per pound was 69.94 above the requirements. The average temperature in combustion chamber was 1,862 degrees. The water evaporated per pound of refuse was 149 pounds; total boiler horse power developed per hour was 482. The horse power used in the plant was 118, giving an excess of 364 as against 330, the contractor's guarantee. The total number of charges of both furnaces was 440.

The final test was made on August 21-22. While the duration of the test was to be 24 hours, the amount of refuse delivered during this period, 138 tons, was destroyed in 21½ hours. The detailed data as regards this test are as per statement accompanying.

From the operation of the plant and from the test made, the opinion of the writer is that Savannah has a high temperature incinerating plant capable of destroying without difficulty 130 tons refuse per day, of furnishing by-product steam of an amount that will result in a saving of at least from $6,000.00 to $7,000.00 per year with the refuse now delivered to the plant. The plant has now been in operation for six months. No defects have been noted and no changes of any moment have been made since the plant was first put in operation. The city is destroying this garbage in a sanitary manner. It has been noted during the summer that the fly trouble has been very much less than in years past, and by some this is thought to be due to the elimination of the dumping of the refuse near the city.

I highly recommend to moderate size cities the destroying of garbage in the same manner as Savannah is destroying here. With cities of large populations and where the percentage of grease is greater than 3 per cent. in weight of the true kitchen waste, the method of destroying garbage by the reduction process may be favorably considered.

Results of Test of Heenan Destructor at Savannah, Ga., August 21-22, 1914.

Duration of Test—3 a. m. 21st-12:30 a. m. 22nd, 21½ hours.

Type of Refuse—	Garbage	45 per cent.
	Rubbish	40 per cent.
	Manure	5 per cent.
	Ash	10 per cent.

Type of Destructor—Two Four-Trough Grate Furnaces with forced draft.
Number Furnaces at Work—Two.
Total Grate Surface—160 square feet.

Type of Boilers—Wickes' Vertical Water Tube Equipped with Foster Superheaters.

		Builder's Guarantee
Total heating surface of each boiler	2,000 sq. ft.	
Total refuse burned	277,550 lbs.	
Total refuse burned per hour	12,909 lbs.	10,833 lbs.
Total refuse burned per sq. ft. grate surface per hour	80.6 lbs.	68 lbs.
Total clinker and ash (approx.)	68,608 lbs.	
Percentage of clinker and ash obtained from refuse burned	24.7%	
Maximum combustion chamber temperature	2,000°F.	
Minimum combustion chamber temperature	1,700°F.	1,250°F.
Average combustion chamber temperature	1,845°F.	1,500°F.
Average steam pressure (gauge)	120 lbs.	
Average temperature of steam	523°F.	
Average superheat	173°F.	100°F.
Average temperature of feed water	206°F.	
Total water fed to boiler	397,162 lbs.	
Total water evaporated from and at 212 F.	450,382 lbs.	
Total water evaporated per lb. of refuse	1.62 lbs.	1.3 lbs.
Water evaporated per lb. of combustible	2.15 lbs.	
Total B. H. P. developed per hour	607 lbs.	
Estimated H. P. used in plant for 75 K. W. non-condensing, Turbo generator set and boiler feed pump	118	
Excess B. H. P.	489	390
Average air pressure under grate	3¼ inches	
Average air temperature	252°F.	
Average stack draft	.72 inches	
Average CO 2	11.43%	
Total number charges, both furnaces	447	
Average weight of charge	621	
Total number clinkers drawn, both furnaces	64	
Cost of operation, based on contract—		
Hoisting—one man per shift of eight hours @	$2.40	$2.40
Stoking—four men per shift of eight hours @	2.40	9.60
Clinker removing—one man per shift of eight hours @	1.50	1.50
Engineer—one engineer of eight hours @	4.00	4.00
Total labor charges per shift		$17.50

Total labor charges per day of 24 hours.........		52.50
Total labor charges per ton @ 130 ton rate.....		.404
Cost of operation, based on actual cost—		
Hoisting—one man per shift of eight hours @..	$2.25	$2.25
Stoking—four men per shift of eight hours @..	1.75	7.00
Clinker removing, one man per shift of eight hours @..............................	1.50	1.50
Engineer—one engineer per shift of eight hours @.............................. ..	4.00	4.00
Total labor charge per shift.....................		$14.75
Total labor charge per day of 24 hours..........		44.25
Total labor charge per ton @ 130 ton rate......		.3403
Total labor charge per ton for 138.75 tons in 21½ hours		.318

Remarks.

Test made with running start. All hoppers were empty, and then charged with test mixture. On completion of test, hoppers were empty. All combustion-chamber temperatures taken with thermo-electric recording pyrometer. All other temperatures were taken with mercury thermometers. Water measured with a Worthington hot-water meter. Steam pressures taken with a recording pressure gauge connected to main steam line. Steam delivered to main header at water works, and used to operate one 10,000,000-gallon pumping engine and one 1,850- cu. ft. cross-compound condensing air compressor. From 12:15 to 5:10 p. m. air compressor was operated non-condensing. From 6:30 to 10:30 p. m., 10,000,000-gallon pump speeded up. Steam from plant also used to operate all prime motive units for generation of power for use in plant. At 7:00 a. m., August 22, all refuse in storage pit was burned, and from then until 8:00 a. m., insufficient refuse was delivered to keep the plant going at capacity.

Weather during the test was hot and humid, with occasional showers. Test was started at 3:00 a. m. of 21st and completed 12:30 a. m. of 22nd. All calculations based on

A. S. M. E. standards. Safety valves of boilers were popping off from 5:30 p. m. until 6:30 p. m.

DISCUSSION.

MR. MILLER: Do you make any use of the clinker?

MR. CONANT: Not to any extent. The nature of the garbage is such that there are too many tin cans and considerable iron, and to separate the iron and the tin from the clinker would cost more than its commercial worth. I have selected some pieces of the clinker, and made concrete for foundation work, and it was entirely satisfactory. I have tried to dispose of the ash, which contains a good deal of phosphoric acid, to the fertilizer plants for what they call their filler, but as yet haven't succeeded in disposing of it.

MR. MILLER: You don't separate your garbage?

MR. CONANT: No, Sir.

MR. SHERRERD: What is the power delivered to the water plant, in horse power?

MR. CONANT: During the test it was about 400 net h.p., delivered to the plant, in excess of that used to operate the plant.

MR. SHERRERD: The material that was burned, was that any different from your usual run, or was that a collection of several days?

MR. CONANT: It was somewhat different from the regular run, in that we had to increase the amount of garbage to bring it up to the percentage specified in the contract. This test was made in accordance with the specifications, which required so much garbage, so much ash, so much rubbish. We had to increase the wet portion for that test.

MR. SHERRERD: Under ordinary operation have you been able to furnish power to the water plant continuously?

MR. CONANT: It has been furnished continuously for six months, every day.

MR. SHERRERD: What degree of power?

Mr. Conant: Sufficient to save $600 worth of coal per month, and we expect to increase that.

Mr. Sherrerd: I was wondering whether there were any interruptions during that period.

Mr. Conant: When we first operated the plant the refuse was not sufficient to keep the two units going, and the furnishing of steam was more or less interrupted. Now, with 75 to 80 tons daily, we are burning it all on one unit.

Mr. Sherrerd: You are operating that unit at its maximum?

Mr. Conant: Yes, sir. And delivering steam uniformly to the water plant during the twenty-four hours.

Mr. Hanson: What kind of labor do you employ, and about what do you pay for it? What sort of supervision do you have over it, and have you difficulty in getting satisfactory labor? How much elasticity can you obtain in the operation of the plant? That is, what is the lowest load you can place on it, and what is the largest, to take care of fluctuating collections? You speak of its being applicable to cities of moderate size. What would be the limits you would set?

Mr. Conant: The stoker labor is colored, and with the exception of one or two men, the same gang is working today as when the plant first went into operation. They are paid $1.75 a day. We work three shifts. The cranemen are paid $2.25; the engineers $4, and a laborer around the plant $1.50. As to elasticity, you could of course have a plant of one unit, but to use the by-product somewhat commercially, the cost of that plant for a small amount of refuse would be too great. Perhaps a 50-ton unit would be the lowest. You would have to reduce your shifts, if you had not enough for one unit. I am burning 75 to 80 tons; if we had but 50 tons, we would use one unit perhaps for twelve hours, and then bank the fire, and then, when you made collection of garbage the next day, all you would do is add refuse to the fires and start again. It is necessary to operate the unit to full capacity, even though you cut down the time of work. It is necessary to deliver steam

uniformly; if you deliver it spasmodically, unless you have perfect co-operation between the two plants, the crew at the pumping station would not know when you were going to slacken your steam, and it would make trouble. It is better to arrange the consumption of refuse so as to make as even a delivery of steam as possible.

MR. HANSON: You couldn't operate half a unit?

MR. CONANT: Not very well.

MR. HALLOCK: Has the plant been accepted by the City of Savannah?

MR. CONANT: Practically, yes. The final payment I presume is being made today, but so far as the operation is concerned, it was a foregone conclusion some weeks ago of its acceptance.

MR. HALLOCK: This is certainly very important and interesting to engineers. As I understand it, Mr. Conant's report is that the actual performance has exceeded the guaranty, not only in temperature, etc., but also in the horsepower of steam produced. I had heard there was some question as to the acceptance of it.

MR. CONANT: None as to operation. There was one question raised as to not testing the meter at the time the test was made, and we had to make a special test of that afterward. That delayed for a few days. Then there was a little trouble between the company and the sub-contractor that delayed the final settlement a short time, because the city did not want to get mixed up in it.

MR. HALLOCK: Was it possible to maintain the temperature of 1,250 degrees during the period of the year when you were using 55 per cent. garbage?

MR. CONANT: It fell to about 1,300 for a portion of the time when we were burning the excess amount of melon rinds, but with the refuse we are collecting most of the time, I am afraid the temperature is going too high. We are sprinkling, when the refuse is too dry, to reduce the dryness, the temperature in the chamber, for if it goes up over 2,000 degrees, I fear

it will injure the lining of the chamber; we believe it should be kept from 1,500 to 1,800 degrees.

Mr. Hallock: One of the most successful incinerating plants we have, the one at Westmount, Canada, has an average temperature of 2,240 degrees. The bucket you use in transferring your garbage, is that an orange peel or a clam shell?

Mr. Conant: It is a Haywood clam shell of a yard capacity.

Mr. Hallock: Are there teeth on it?

Mr. Conant: Yes; we had to put teeth on to break up the boxes and barrels that are dumped in with the refuse.

Mr. Hallock: You spoke of cost of collection being $2.29 a ton. That strikes me as higher than the average. Are there unusual conditions that would bring that up?

Mr. Conant: From my study that is somewhat less than the average. I think the mean cost of collection in about twelve cities is $2.42. We collect entirely by wagons; no motor apparatus; an average haul of about a mile and a half, colored labor; these figures include repairs to wagons, proper overhead charge for the stables, feed for stock, and everything pertaining to the collecton.

Mr. Hallock: Collections are made by the city department?

Mr. Conant: Yes, sir.

Mr. Hallock: And that includes collection from the houses and delivery to the plant?

Mr. Conant: Yes, sir.

Mr. Macallum: In your net saving do you include interest on your capital invested and sinking fund?

Mr. Conant: No, sir.

Mr. Thompson, of New York: This hoe arrangement for removing clinker, does that remove it without supplemental breaking up at times?

Mr. Conant: Yes, sir. We experimented with different types and sizes of hoe. We started with a shallow hoe, and had to increase it until the section of the hoe was nearly equal

to the section of the furnace, and with this, operated with a winch and hydraulic ram, we have no trouble.

MR. THOMPSON: You spoke about supplementing your fuel with cinder, was that cinder from the ordinary collection?

MR. CONANT: The ordinary ash and cinder collection from manufacturing plants.

MR. THOMPSON: And the percentage of clinker and ash obtained you stated to be 24.7 during the test. Does that obtain during the general average of the year, or is it higher than that?

MR. CONANT: It varies with the type of refuse; it is sometimes as low as 20 per cent. and perhaps goes up to 30 per cent.

MR. THOMPSON: The character of the refuse and garbage collected in the southern cities differs considerably from that collected in the north, and would the percentage of ash be greater or less here in Boston than in Savannah?

MR. CONANT: Greater.

MR. OSBORN: I have been watching what Mr. Conant has done at Savannah, and the City of Savannah is to be congratulated on having a man like him to handle the proposition. What he has done at Savannah no doubt excels the experience of the majority of cities. To make an installation, make the tests, and have a successful plant accepted by the city reflects great credit on Mr. Conant, and we must appreciate the work he has done. As to the trough grate, I would like to ask a question. When you withdraw your clinker in the flat grate, there is usually enough material left to start the recharge. What method do you use for recharging after the clinker has been withdrawn?

MR. CONANT: After the clinker is withdrawn, the stoker pulls down from the furnace adjoining a small amount of the burning refuse, before dropping the charge from above. That would not be necessary to ignite the next charge, for the reason that the furnaces are open, one with another, and the heat from the adjoining furnace would ignite the charge; but you want to start the burning from the bottom, get your heat

from the bottom, so as to surely cook and dry the garbage as it is delivered from above.

Mr. Osborn: I saw one plant where in recharging they were using wood to get it started.

Mr. Conant: That has not been done with us, except where the fires of one unit would be entirely put out, so as to clean out the chambers underneath; then some dry wood, selected from the refuse brought to the plant, would be put in.

Mr. Osborn: Suppose you had sufficient horsepower to operate the water plant; would you consider it advisable to try to run the water plant on your power alone, without an auxiliary boiler?

Mr. Conant: No, because of chance of fire. Savannah pumps its water from artesian wells, and by pressure supplies it all over the city. There is no gravity flow, and in case of fire it would be very risky to depend on a plant simply burning refuse. The way they do is to keep their fires banked at the pumping station, and use the steam from the destructor when it is available.

Mr. Norton: What was the result of your analysis of the ash? How near did your phosphorus content come to making your ash a salable product?

Mr. Conant: The percentage of phosphoric acid was six and a fraction per cent., but it is in a form that is not available. If it were available, it would be valuable, but if you spread it over the land, it might be a long time before it would be of value. The fertilizer plants said if it were available, they could use it.

Mr. Norton: Buffalo has two forty-ton plants used to destroy refuse alone, and from which they get about 50 per cent. recovery of salable material. I have thought there might be recoverable value in the ash, as we sell everything but the ash.

Mr. Conant: We have a beach there near the plant, and the companies use beach sand as filler, and sell it to the farmers for $20 or $30 a ton.

MR. NORTON: Is there anything at all in the ash that is salable?

MR. CONANT: No.

MR. NORTON: Our ash would be largely from wood pulp or paper, and would, of course, contain some potash.

MR. OSBORN: It is such a low grade material that it would not pay the fertilizer companies to remove it on account of the cost of removing, and the small amount of plant food there is in it. As to the fertilizer companies using sand, they use sand and cinders as fillers, because they have to build up their material. The farmers demand a certain grade of fertilizer, and by state law that is required to carry a certain analysis, and if it were all composed of high grade material like tankage or phosphate rock, it would be too rich to put on the land. They have to furnish the bulk, and are forced to add a filler to make up the bulk and bring down the fertilizing elements in the material.

MUNICIPAL CLEANLINESS.

By Irwin S. Osborn, *Consulting Engineer of Department of Street Cleaning and Refuse Disposal, Toronto, Ont.*

Of the many problems confronting the municipal official, one of the most important is the cleaning of streets and the collection and disposal of refuse. This branch of municipal work is conducted for the most part, before the public eye. The methods and results are open for inspection and criticism at all times, which is not the case with other branches of municipal service.

In the collection of refuse, the rank and file of the organization come in close touch with the householders, and any failure to fulfill obligations is at once noted.

The continually increasing demands of the public for better standards of cleanliness and expeditious methods of work, forces the wide-awake official in charge of this branch of the service, to be continuously on the lookout for new developments, which will assist in improving the service.

Many changes and improvements have taken place in the methods adopted for street cleaning, refuse collection and disposal, during the past few years. These changes and improvements have been the result of:

(a) A desire for better sanitary conditions on the part of the public.

(b) The tendency to raise all municipal work to a higher degree of efficiency.

(c) The appointment of officials whose ambition has been to place their departments on an efficiency basis.

(d) The comparison of the results obtained by other municipalities, where the problem has been given proper consideration.

It is to be noted that the cities that have led in this work, in many cases are not those of our own land, but those situated in older portions of the world.

Signs are not, however, wanting to show that American cities are waking up to the fact that in this important work they are behind, and where they have seriously tackled the problems, results show that we can equal and perhaps excel, in applying efficient management.

The trouble has been a tendency to pass over as unimportant, this portion of municipal work, not placing it on a level with such enterprises as water and sewage disposal plants, etc., but entering into it without study and engineering advice.

In every city we find variable conditions as to kinds of pavement, maintenance of pavements, grades, traffic, climatic conditions, etc., which make it necessary to adopt different methods of cleaning, and a comparison of the degree of cleanliness attained is difficult to establish.

For this reason, universal standard methods cannot be established, or definite comparisons made. Moreover, where the same methods are used under like conditions, the results will differ—due to difference in organization.

The cost of the work in various cities cannot be compared, as the system of record keeping is not standardized.

With the interest that is now being taken in this problem, we can look to a rapid advance and a future of standardized work that will compare with the operation of other branches of municipal service.

In company with Mr. Fetherston, last summer I visited a number of European cities, to study methods of street cleaning, refuse collection and disposal. In the German cities especially, one could not help but admire the efficient and effective work of the department, as a result of the individual study of each problem and effective execution of the work, after the solution had been found.

EUROPEAN PRACTICE.

Street Cleaning.

The equipment and general methods used by European cities are largely the same as used on this continent. Conditions there vary, the same as ours. They also lack the standardization already referred to, but they have the following advantages:

(a) Every city has its trained expert to systematize and develop its organization. This, in their opinion, is true economy and results attained prove the policy correct.

(b) In the average European city, the streets are more fully paved and maintained in better condition than in the average city of this country.

Refuse Collection.

In the majority of cities refuse is collected by the municipality which has given special attention to the collection problem. Garbage, ashes and rubbish are collected in a combined state, with a vehicle having a closed body, thus preventing the scattering of material or dust.

In a few German cities, special vehicles having a sectional body have been developed, to be used in connection with a standard receptacle, whereby the material is not exposed at time of collection or when it is discharged into the furnace.

Refuse Disposal.

The modern tendency of refuse disposal in European cities consists in total incineration, in municipally owned plants.

The greatest advance and development in the design of incinerator plants has been made by the British, but during the past few years the German engineers have given special attention to furnace design, developing a type of high temperature furnace differing from the British destructors in detail and operation. The German furnace designers have adopted the single cell and combustion chamber in place of the multiple cell and continuous grate used in England. Also, an increased

pressure and temperature of the air used for forced draft in the furnaces.

METHODS IN EUROPEAN CITIES.

Berlin, the capital city of Germany, has the reputation of being the cleanest city in the world. This reputation seems evident to the tourists, who oftentimes ask the question, "Why are our streets not kept as clean as they are in Berlin?"

With the excellent condition of pavements, enforcement of regulations, low cost of labor and large force, as well as the efficient and active organization and the continual cleaning of the main thoroughfares during a twenty-four-hour period each day, no doubt Berlin has reached a standard of cleaning which will be hard to equal under American conditions.

The advance and development of the Berlin Street Cleaning Department dates back to 1875, when the entire work of street cleaning was taken over by the municipality. The management of the department is under the supervision of the director. The organization consists of:

One Director.
One Sub-Director.
Nine Chief Inspectors.
Seventy-one Inspectors for Office and outside service.
One hundred and five Foremen.
Eighteen hundred men.
Six hundred boys.

The men starting in the service receive 93 cents per day, with increases during the time in the service and after nine years' service, receive $1.11. The foremen receive $1.19 per day, and after three years' service receive $1.25.

The boys who are employed work as apprentices, receiving 48 cents per day to start, which is increased to 71 cents after four years' service. The boys after serving their time as apprentices, and then in the army, are often made permanent employees.

The usual government oversight relative to workmen's insurance laws, is enforced with regard to employees.

The organization is conducted along military lines. All employees must have military training and not be over 35 years of age at the time of entering the service.

The city is divided into four main districts with a Chief Inspector in each district as Manager. The four main districts are divided into nine divisions which are further divided into thirty-three subdivisions, each subdivision being under the direction of one uniformed inspector with an assistant.

Each of the thirty-three subdivisions are provided with depots, having an office for the Inspectors, as well as a locker, bath, and lunchrooms for the men.

The total area cleaned amounts to approximately 8,000,000 square yards of streets and 4,800,000 square yards of sidewalks. The pavements consist principally of asphalt and stone, with a total area of asphalt equal to all other classes of pavement.

Berlin has within its limits only streets which are well paved, and nowhere do we find unpaved or macadam streets to any extent, so that the formation of dust or material to be removed comprises only that which is created by moving traffic and the formation of dust is only created to a limited extent.

The amount cleaned each day amounts to about two-thirds of the total street area. The methods used are similar to what are found in a number of cities of Europe and America, comprising machine broom cleaning, hand patrol, hand squeegee, and motor squeegee. With the large area of asphalt, the method of cleaning used for this class of pavement consists almost entirely of motor squeegees, supplemented by hand patrol and hand squeegee. The city uses for this purpose, 70 electric motor squeegees. The work by the electric squeegees is done at approximately 20 per cent. less cost than by horse-drawn squeegees.

The collection and disposal of refuse in Berlin is carried on by a private co-operative company working independent, and not under the control of the city, either by contract or municipal regulation. The co-operative company serves approximately

35,000 householders or apartments, with possibly ten times as many families. The refuse is collected in closed collection wagons and delivered to loading stations, where it is loaded on to cars and shipped to a disposal plant, some twenty miles outside the city. The refuse is collected in a combined state. The co-operative company consists of some 3,000 stockholders and 30,000 members. The service is rendered according to request, with a fee charged according to the amount removed and frequency of service. The fees charged for service are sufficient to permit the payment of an annual dividend of six per cent. to the stockholders and in some cases have permitted a rebate of eighteen per cent. to members, as the allowable dividend cannot by law exceed six per cent. In addition to the dividends and rebates, the fees were sufficient to amortise the investments in a period of two years. The disposal is made by a subsidiary company, which is paid a bonus by the co-operative company for disposal.

The disposal of refuse consists in reclaiming saleable material, incineration of combustible material, land treatment, and dumping. The company has been operating for approximately 18 years.

It is often assumed that the work done by this private company is carried on as a municipal enterprise, and the statement made that Berlin makes a profit out of the collection and disposal of refuse, whereas in reality the co-operative company makes a profit at the expense of the members or householders, who are charged fees for the service.

In other European cities we find conditions approaching those in Berlin, but in most cases not carried to the same extent in regard to the organization.

The conditions and methods in the different cities vary, and usually some particular work or method will be found to have received special attention in each city.

In Hamburg and Frankfurt, more special attention has been directed to the problem of refuse disposal.

A special feature of the disposal work at Hamburg is an

English furnace of the "Horsfall" type, which was installed in 1896, and successfully operating at the present time.

In conjunction with the disposal work, this city has developed a specially designed motor truck, permitting its operation from the driver's seat, or by walking at the side for refuse collection service.

At Altoona and Furth, we find the special vehicle with sectional body and standard receptacles, already referred to.

Cologne is developing the electric tractor for operating street cleaning equipment, as well as for other services in the department.

Nuremburg illustrates what can be accomplished in sanitary disposal of refuse by fill, as during the past years a beautiful park has been developed from old sand pits. The disposals by fill is done by dumping the refuse, after which it is mixed and covered with sand, so as to permit aeration and digestion of the material in the soil. The method is not only sanitary in contrast to our practice of dumping, but with credit from development no doubt proves to be economical.

Paris is particularly noted for the development of motor street cleaning and refuse collection equipment, as no other city in the world uses motor equipment so extensively. The modern disposal plants located on four sides of the city, for the disposal of refuse, are no doubt on a more comprehensive scale than that found in any other city, involving as it does, not only furnaces, but a means for utilizing certain waste products.

The traffic conditions in Paris, and size of the city, as well as class of pavements, will not permit of comparison with the methods in Berlin, for the problem is not only greater but more difficult.

London being divided into a number of boroughs, the work of street cleaning is carried on by a separate organization in each. The traffic conditions in the congested parts of London makes the problem more difficult than found in other cities, although the methods used, with some exceptions, are similar.

Two characteristic features of London are the nightly flushing by hose, and the services of the active orderly boys in removing deposits on the pavements to numerous boxes or bins provided for that purpose. These boxes also contain sand, which the orderly boys scatter when climatic conditions demand it.

AMERICAN CONDITIONS.

STREET CLEANING.

There are a number of American cities where the work has been regarded of sufficient importance to warrant the selection of men, specially fitted to devote their energies to this branch of municipal service.

They have directed their efforts toward standardizing methods and obtaining records of work together with unit costs of the same, thus applying scientific management towards this branch of municipal work.

There are a number of efficient men to be found in the various street cleaning departments of both large and small cities, although the majority of the cities have not appreciated the importance of the problem.

Space will not permit the enumeration of the many efficient organizations and organizers throughout the country. A perusal of the various engineering periodicals will show that public sentiment and interest are centering in this direction.

I would like, however, to make special mention of the constructive and organization work of Mr. Fetherston, in the Borough of Richmond, New York City, who has given special attention to developing records, standards of work and unit costs. In his new sphere as Commissioner of Streets, New York City, we can expect greater advance.

The study made by the Bureau of Efficiency in Chicago, and covered in their report on "Investigation Bureau of Streets," demonstrates the possibilities and constructive work that can be done from a standpoint of effective and efficient work.

One of the best examples of an efficient and effective street cleaning organization will be found at Washington, and no doubt the results accomplished in Washington will compare favorably with those to be found in the best European cities.

The conditions in Washington are different from those found in the majority of American commercial cities, as few are as well paved and the streets kept in as good repair, and in addition, the traffic is much lighter.

Notwithstanding the advantages, it demonstrates what an efficient organization and effective methods will accomplish when the problem is taken up and studies and application made. In no other city do we find as complete records kept of the work done, with the unit cost of the same.

The organization and methods of operation of the Washington street cleaning are described by Mr. J. W. Paxton, the Superintendent, in the Engineering News, under dates of July 9th, August 6th, and August 27th, 1914, and merit the study of officials interested in this branch of municipal service.

Refuse Collection.

The methods of collection, as well as the frequency of collection will vary in nearly every American city.

Except in a few cities, very little attention has been given the problem of refuse collection, either from the sanitary or economical standpoint. Special emphasis has been given methods of disposal in many cities, without giving due consideration to collection. We are beginning to realize that the collection is of greater importance and more directly affects the householder than the disposal.

Refuse Disposal.

The methods of disposal vary in different cities. The majority of larger cities have disposed of garbage by contract; the contractor reducing the material into saleable by-products. In the majority of cities, where disposal is made by the municipality, the incineration method, with few exceptions, has been the practice.

The history of disposal methods demonstrates that proper study has not been given the problem, as the results in many cases have not been satisfactory. In cities where desirable results have been obtained, we usually find that special study has been given the subject and with the present tendency of municipalities to realize the importance of the problem, no doubt greater advance will be made.

The majority of larger American cities are making considerable advance, and we can look forward to greater achievements and constructive work in municipal cleanliness, with results as to standards, comparing with other branches of municipal service.

The fundamental principle of municipal cleanliness is sanitation and economy, and all work in connection therewith should be developed from this standpoint.

With trained experts at the head of this department taking up the problem and making studies for determining the proper methods, we will find that the work is reduced to a science from the standpoint of sanitation and economy, and the efficiency, as well as the convenience and comfort of the public, will be greatly improved.

DISCUSSION.

Mr. Osborn: At present we are reorganizing to some extent the street cleaning in Toronto. We have at present a district which includes practically all classes of population, a manufacturing section, a tenement section, and what we call the A class section or better section of the city, and we have all classes of pavement to deal with. We are trying out different methods of street cleaning, in order to determine which is the most economical as well as the most efficient. We are running tests on different pavements, which will give us the cost, and over a period sufficiently long to determine efficiency as well as unit cost for doing the work. So far as our results have gone, if our methods as applied in this one section are applied to the whole city, it will give us a saving in efficiency of ten to twenty per cent. in the year's work, by establishing standard methods.

(Mr. Osborn then showed a number of slides, from pictures taken in European and American cities, illustrating the points brought out in his paper.)

MR. CONNELL, of Philadelphia: Were the receptacles in Berlin furnished by the contractor?

MR. OSBORN: Yes, sir, at the expense of the householder.

MR. CONNELL: The adoption of standard receptacles is of course a tremendous factor for efficient work along this line. Very few of our cities have standard receptacles, and in many cities the legislative bodies refuse to pass laws compelling the property owners to purchase the proper kind of receptacle. The only other way to get the receptacles is to provide that they be furnished by the contractor, but by doing that you raise the cost of collection, and of course raise the tax rate.

MR. OSBORN: In Berlin the city has no jurisdiction over the company. It is an incorporated company which goes out and secures its members among the householders. The fees they charge were sufficient to amortize the total investment within two years, as well as carry on the work and furnish the receptacles.

MR. CONNELL: Is that system of collection used in all districts? Do they serve the people in the poorer sections, places comparable with our slums? Do they have receptacles like those shown by you?

MR. OSBORN: The standard receptacle shown I think is used in but a few cities, Altona and Cologne and Furth. The householder buys it, but the city compels him to. The condition in this country is that if we can get the householder to secure a suitable receptacle, we are doing well, without compelling him to get a standard receptacle. With the system shown, it could not be worked without the standard receptacle, and each householder must have one.

MR. CONNELL: In Berlin do those in the poorer sections furnish the receptacles, and have their collections made by this contracting company?

Mr. Osborn: In Berlin it is a large receptacle, which runs up to five or ten gallons, and is not a standard receptacle.

Mr. Connell: Do they collect garbage from every section of the city?

Mr. Osborn: Yes, from every section that will pay the fees.

Mr. Connell: Who collects it from the sections that do not pay them?

Mr. Osborn: The whole city is served by this company, as near as I could learn.

Mr. Connell: Where you show collection wagons and street cleaning apparatus, is that used in the entire city, or is it the case of certain types of machine being used in a small way, as in some of our American cities?

Mr. Osborn: In Paris they have built a large garage which will handle 140 motor trucks. They had 70 then, and expected the rest soon. The street cleaning equipment is standard, with a number of each machines in operation.

Mr. Connell: From your observation and investigations over there, don't you attribute their efficiency to the fact that they have taken matters more seriously over there, and that this work has been under the supervision of engineers, men qualified for the work, instead of, as in this country, under the supervision of political appointees?

Mr. Osborn: I think there is no doubt but that is the case. Those officials are appointed for life, and grow up with the departments, and it is their life work to develop efficient methods. The conditions there are different. The American cities will produce three times per capita the amount of refuse produced in a European city. Then, with us, the official is usually appointed for but a short term, he may be in office four years, and that is scarcely time to work out a constructive policy.

REPORT OF COMMITTEE ON SEWERAGE AND SANITATION.

Your committee had thought of presenting to you tables showing the character and extent of sanitary construction during the past year but upon some investigation it seemed that so much of this tabulation was in progress and upon so many varied subjects, that it would be wise to abandon this effort and confine our endeavors to securing original papers upon fresh topics from various parts of the country. This should make a more acceptable review of the progress of this branch of engineering. Acting upon this thought, letters were addressed to members of this Society residing in different sections and quite a number responded favorably and we have been very fortunate in securing a number of papers of decided interest which will be presented to you during the evening.

They are as listed below:

"Sewage Disposal Works, Preliminary Investigation Required."—E. A. Fisher, Consulting Engineer, Rochester, N. Y.

"Converting an Old Septic Tank Into a Modern Two-Story Tank."—Alexander Potter, New York City.

"The Milwaukee Sewerage Problem."—T. Chalkley Hatton, Chief Engineer, Milwaukee Sewerage Commission.

"Economics of Sewage Filters."—George W. Fuller, Consulting Engineer, New York City.

"The Experimental Sewage Disposal Plant of Brooklyn, New York."—George T. Hammond, Engineer in charge.

"The Discharge of Inflammable Wastes Into Sewerage Systems and the Problem of Prevention."—Norman S. Sprague, Superintendent, Bureau of Engineering, Pittsburgh, Pa.

"Permanent Sediment Records for Water and Sewage."—

George C. Whipple, Consulting Engineer, New York City; Professor of Sanitary Engineering, Harvard University and the Massachusetts Institute of Technology.

Tentative promises for furnishing additional papers were given us by several other engineers, contingent upon their being able to spare the time from their professional engagements but as yet these have not reached us.

The committee wishes to record its appreciation of the hearty and prompt responses received from its numerous requests and to express its thanks to the members who have so kindly given of their time for our benefit and pleasure.

ALEXANDER J. TAYLOR, *Chairman.*
N. S. SPRAGUE.

SEWAGE DISPOSAL—PRELIMINARY INVESTIGATIONS REQUIRED.

By Edwin A. Fisher, *Consulting Engineer to City of Rochester, N. Y.*

Sewage has been defined as the "water supply of a town or city after it has been used." This water supply polluted by such use must eventually be discharged into a stream or a large body of water.

Sewage disposal, as commonly considered, refers to a method of disposal that will prevent a nuisance. The method required for a satisfactory disposal varies, according to local conditions, from the complete purification by filtration through beds of sand to the disposal of untreated sewage directly into a stream or large body of water.

Many attempts have been made by governing bodies to enforce general requirements for all disposal plants. The following reference to special investigations is given to show the necessity of treating each case by itself.

Great Britain was the first in the field in the study of sewage disposal problems. This was forced upon them, due to the fact that the rivers were small and the population dense.

The local governing board having charge of these matters required, except in exceptional cases, the sewage or effluent to be disposed of on an adequate area of suitable land before its discharge into a stream.

In 1898 a Royal Commission was appointed to deal with the question of sewage disposal. Mr. Kuichling, in commenting on the report of this commission states that it was composed of some of the foremost sanitarians, physicians, chemists and engineers of Great Britain, such as Richard Thorne, Prof. Michael Foster, Prof. William Ramsay, Dr. James B. Russell and Gen. James C. P. Carey.

The commission mentioned held 144 meetings and called before it 200 witnesses, all of which were experts in their respective occupations.

In its fifth annual report, issued in September, 1908, the commission expressed the general conclusion that it is practical to purify the sewage of any town to any degree required, either by land treatment or artificial filters, etc. The choice of a scheme, however, must depend on a large number of conditions. The commission was careful to emphasize the view that the circumstances in different towns vary to such an extent that it is impossible to apply the same general rules or systems to all cases.

Mr. Kuichling again says, that "from the aforesaid conclusion of the commission it is reasonable to infer that the subject of sewage disposal is by no means simple, and that a useful knowledge of this difficult art cannot be obtained quickly by the hasty perusal of a small quantity of popular scientific literature which has mostly been written by persons without adequate practical experience, or by those who have financial interests in the exploitation of special methods of treatment."

Mention may be made of the thorough and intelligent investigation in America by a commission known as the Metropolitan Sewerage Commission, appointed in 1906, for the purpose of investigating the question of sewage disposal for the City of New York. This commission consisted of Dr. George A. Soper, President; James H. Fuertes, Secretary; H. DeB. Parsons, Charles Sooysmith and Linsley R. Williams. Its final report was presented unler date of April 30, 1914, in a printed volume of nearly 800 pages.

The commission, in addition to its own investigations, called before it a large number of experts on sewage disposal, among whom were Mr. Samuel Rideal, on oxidation processes applicable to New York conditions; Dr. Carl Imhoff, upon the use of Emscher tanks in purifying the harbor; X. H. Goodnough, Chief Engineer of the Massachusetts Board of Health, on the discharge of sewage into the harbors of Boston and

New York; Dr. Gilbert J. Fowler of Manchester, England, and Mr. John D. Watson of Birmingham.

In the summer of 1913 the commission also called Mr. George W. Fuller and Mr. Rudolph Hering.

Mr. Hering said that "the sewage problem in New York is more complex than in any other large city, as the work of the commission has demonstrated. Its solution depends upon scientific knowledge and practical experience. It can be aided by results satisfactorily obtained elsewhere under similar conditions. It depends also upon the opinions and desires of the inhabitants. Some conditions and some people will demand higher standards, and therefore generally greater expenditures for some cities than for others. The circumstance has occasionally made the solution difficult and slow of adoption.

"Municipal expenditures should be divided in such proportions among the different demands of a community that the results obtained are fairly well balanced in all directions. * * * In Europe this proportionate expenditure generally receives more attention than here.

"The problem may be divided, in my opinion, into three groups: One relating to health, another to science, and a third to cost. * * * The paysician usually deals with the first, the engineer with the second, and the public must deal with the third group."

The Board of Estimate and Apportionment of New York City appointed a commission of Engineers of which Mr. Nelson P. Lewis, chief engineer of the board, is chairman, to coordinate the work of the Metropolitan Sewerage Commission with that of the various boroughs of the city.

Among other cities that may be mentioned where extensive investigations of methods of sewage disposal have been made, is Toronto, whose investigations extended over a period of at least ten years. The leading experts in both this country and in Europe were consulted before final plans were adopted.

The City of Baltimore, with a population of over half a million, up to a few years ago had no sewerage system, and

practically no sewers. An extensive and thorough investigation resulted in a legislative act for a complete system of separate sewers and for the most efficient purification system known to sanitary science. The works, now nearly completed, unhampered by past construction, and intelligently planned and executed, afford what is probably the best example of modern sewer construction and sewage disposal anywhere in America.

Many other cities are waking up to the fact that increase in population and the advance in sanitary science require changes in method of sewage and waste disposal.

Milwaukee has recently called from his well earned retirement from professional work a Past President and charter member of this Society, Mr. George H. Benzenberg, and insists that he serve his city as chairman of its recently created Sewerage Commission.

The City of Cleveland is also carrying on extensive experiments and investigations relative to the proper disposal of its sewage which is now discharged, without treatment of any kind, direct into Lake Erie.

The Massachusetts State Board of Health has for many years carried on extensive investigations in the field of sewage disposal, and its reports have contributed, perhaps more than other agency in America, to the increase of knowledge in this branch of sanitary science.

Pertinent to this question, an editorial in "Engineering News," of October 2, 1913, referring to the preliminary report on the pollution of boundary waters (United States and Canada) says, among other things, "A refreshing spirit of common sense runs through this report," and further, that "Another indication of the common sense spirit is its indorsement of Findings 10 and 11 of the Report of the Committee on Standards of Purity, George C. Whipple, chairman, submitted on October 22, 1912, to the National Association for Preventing the Pollution of Rivers and Waterways." These findings embodied a rational basis for the regulation of water pollution in

accordance with local conditions, taking into account the burden which can reasonably be placed upon water purification plants.

George W. Fuller, in his work on "Sewage Disposal," says, under the heading of "Changing View Point": "Many sanitarians and medical men are clamoring stoutly for the elimination of all sewage matters from American streams. Literally, this is impossible. No longer can there be streams of pristine purity in populous districts. This is one of the penalties of civilization. On the other hand, it may be freely stated, that many streams are now polluted to a disgraceful degree. Corrections are most urgently needed. * * * Theoretically, the treatment of sewage should not be made so complete that the sanitary benefit derived therefrom is incommensurate with the cost involved. This subject is ably dealt with in a report by Messrs. Hazen and Whipple, indorsed by Messrs. Stearns and Eddy, on "Sewerage and Sewage Disposal Conditions at Pittsburgh, Pa."

At a session of the International Association of Municipal Hygiene, held at Chicago, September 29, 1911, there was formed the Great Lakes International Pure Water Association. At the meeting in question considerable attention was given to available information, and particularly as to the policy to be adopted.

The medical men present seemed to favor strongly the thorough purification of all sewage, whereas the engineers present endeavored to point out the wisdom of treating each problem on its merits and purify the sewage little or much, as occasion required. The following resolution was adopted:

"*Resolved*, That the chairman of this meeting be instructed to communicate to the principal national authorities of the United States and Canada that it is the opinion of the health officers and other sanitarians here assembled, that no city should be allowed to pour untreated sewage into the waters of the Great Lakes in any case where the water supply would be endangered; that harmful trade wastes should not be allowed

to be poured into such waters, and that boats plying these waters should be required to make adequate provision for the disposal of their sewage."

The purpose of referring at length to the investigations described is to emphasize the fact universally recognized by all sanitary engineers, that no general rules or regulations can be adopted covering all cases, and that each case should be taken up individually. The health authorities having jurisdiction of that matter should use the largest degree of common sense in dealing with the problem.

The City of Rochester was among the first of the cities bordering on the Great Lakes to voluntarily take up the scientific treatment of its sewage. It may be of interest to briefly recite the steps in the investigation and give a general description of the works now nearing completion.

The City of Rochester is situated in Monroe County, state of New York. The central portion is about 263 feet above the level of Lake Ontario, seven miles northerly, and 510 feet above mean tide water.

The Genesee river, flowing through the city northerly to Lake Ontario, has three falls and several rapids within the corporate limits, with an aggregate fall of about 260 feet.

The Erie canal passes diagonally through the city. The new Barge canal, which will take the place of the Erie canal, passes through Genesee Valley Park about three miles south, and will connect with the center of the city through the Genesee river. The drainage area of the river is about 2,400 square miles; minimum flow in Rochester 200 cubic feet per second; average in summer 500 to 1,000 cubic feet; minimum flood flow about 50,000 cubic feet; average rainfall, 32.50 inches.

Water supply, domestic from Hemlock Lake, 30 miles south, in 1913, 21,500,000 gallons per day; river water fire service, 2,200,000 gallons. Average, per capita, about 100 gallons.

The population	in	1880	was		89,366
"	"	"	1890	"	138,896
"	"	"	1900	"	163,500
"	"	"	1905	"	181,670
"	"	"	1910	"	218,129
"	"	"	1914 est.		245,000

The sewers in the main portion of the city are of the combined system. In the newly annexed territory, called the Brighton Districts, the sewers are on the separate system. The total length of sewers in 1913 was approximately 275 miles. The total length of streets in 1913 was about 360 miles, of which 230 miles are improved.

The surface water enters the combined system through surface sewers without catchbasins. The total area tributary to the main disposal plant is approximately 15,500 acres.

In the year 1887 the Common Council appointed a special committee to investigate and report upon the East Side Belt Line Sewer. The committee selected from a number of engineers Mr. Emil Kuichling, then a resident of this city, as the engineer to make the investigation and plans for this sewer, and also to report upon a purification system. This report was made on April 29, 1889.

The Belt Line Sewer, thereafter called the East Side Trunk Sewer, was planned and built at such an elevation that the sewage could be taken from it to any point north of the city that might be selected, for treatment. The entire sewage of the city from that time until the present has been discharged into the Genesee river without any treatment whatever.

No very serious complaints were made concerning the condition of the river until about the year 1900. The condition of the river, however, continually grew worse, and in the year 1904 Mr. Kuichling was again employed to investigate and report upon the question of the sewage disposal for the entire city.

These investigations were continued until February, 1907, when a report was presented to Hon. James G. Cutler, then mayor of the city, which report and recommendations were concurred in by Messrs. George H. Benzenberg of Milwaukee, then President of the American Society of Civil Engineers, and Rudolph Hering of New York City.

On account of extensive improvements in the water works system then going on, and the nearness of the city to the debt

limit, it was impracticable to proceed immediately with the construction of the work as recommended. Mr. Kuichling was then retained to make further studies, especially in elaboration of the plan recommended.

In March, 1910, he made a supplemental report entitled "Notes on Sewage Disposal," in which all methods of treatment were discussed and comparative estimates of the cost submitted.

Mr. Kuichling in his first report in 1889 discussed four methods of disposal; 1, by chemical treatment; 2, filtration through land without cultivation; 3, sewage farming, or filtration through land with cultivation, and 4, discharge of crude sewage into the lake. At that time he favored the chemical treatment and suggested the location of a treatment plant on the east side of the river about a mile north of the city line.

In his later reports of 1907 and 1910, which reports were concurred in by Messrs. Benzenberg and Hering, he favored the use of detritus tanks for the removal of the heavier matter in the sewage, followed by fine screens such as had been successfully used in many of the German cities.

On February 26, 1910, by direction of his honor, Mayor Edgerton, the writer presented general plans for improving the sewerage and sewage disposal of the city of Rochester to Hon. Eugene H. Porter, then Commissioner of Health of the State of New York.

Before submitting his final report the City Engineer and his Principal Assistant, Mr. John F. Skinner, accompanied by Mr. Kuichling as consulting engineer, inspected the sewage disposal works of Worcester, Providence, Boston, Cleveland, Columbus, Reading, and the completed plans of plants in process of construction at Toronto and Baltimore. Advantage was also taken of the experience of many other cities both in this country and Europe during the six-year period in question.

The plans as submitted provided for the collection of the sanitary sewage together with an additional two and one-half volumes of storm-water in the system of intercepting sewers,

and the conveyance through a trunk sewer to disposal works located about one-half mile from the lake front, and about 60 feet above the surface of the lake.

The treatment of the sewage by passing through a series of detritus tanks operated so as to make the mean velocity not more than two inches per second, when storm-water was being treated, and not less than about one inch per second during dry weather, in order to avoid the formation of much offensive sludge. After flowing through the detritus tanks in the manner indicated it was intended to pass the sewage through screens having a clear opening of about 1-12 inch or less in width.

Commissioner Porter held a public hearing on the proposed plans in the common council chamber at Rochester, on June 9, 1910. In opening this meeting Dr. Porter said, among other things, "When we come to the question of sewage disposal at the present time I think it is safe to say that there are certain underlying principles which are of universal application, but every particular case must be decided upon its individual merits. * * * The question of the proper disposal of the sewage of the city of Rochester is a part of the greater problem of the sanitation of our Great Lakes, which now takes into consideration every city and municipality that is now, or may later, discharge into the Great Lakes.

The hearing developed no intelligent opposition to the plans as submitted, and resulted in no suggestions of improvement.

The State Commissioner said, "Believing that the city of Rochester should have the best advice in this matter that the department could give it, I submitted the matter of the approval of these plans to three of the leading experts in sanitary engineering in this country—Messrs. Allen Hazen of New York City; X. H. Goodnough, engineer of the Massachusetts State Board of Health, Boston, Mass.; F. Herbert Snow of Harrisburg, engineer of the Pennsylvania State Board of Health, as well as to Theodore Horton, engineer of the New York State Board of Health.

The questions regarding which they were requested to express an opinion were as follows:

1. Will the system of intercepting sewers removing from the Genesee river the raw sewage of Rochester, except during time of storms, eliminate practically all nuisance from the river in and below the city of Rochester?

2. Will the overflow of sewage during storms after proposed plans are executed, produce any nuisance along the river in or below the city?

3. Will the effluent from the proposed sedimentation and screening plant, after discharge into lake, 7,000 feet from shore in 55 feet of water, produce any nuisance in the lake at the point of discharge or beyond a very limited zone immediately surrounding such point of outlet?

4. Will the pollution affecting in any way the senses, occur along the lake shore as a result of discharge of the effluent from the proposed sedimentation and screening plant, under adverse conditions of wind or wave action?

5. Will any chemical or biological traces of sewage ever be found so far distant from the outlet as along the shores of the lake?

6. Will the sewage effluent from the proposed sedimentation and screening plant, discharged at a point 7,000 feet from short in 55 feet of water result in less pollution along the shores of Lake Ontario, east or west of the mouth of the Genesee river, than now occurs from the raw sewage discharged into the Genesee river, and in turn into the lake at the mouth of the river?

7. Will any pollution from the discharge of effluent from proposed settling and screening plant reach the shores of Lake Ontario in amounts and under conditions that will injuriously affect bathing along these shores or appreciably menace the health of bathers?

8. Will the organic matter remaining in the sewage effluent after treatment in the proposed sedimentation and screening plant, be ultimately completely oxidized before any

such organic matter has traveled any considerable distance from the outlets?—especially before it could travel as far distant as 7,000 feet, to the nearest short of the lake?

9. Will the discharge of the effluent from the sedimentation and screening plant under the proposed conditions affect the potability of the filtered water supply of Rochester and Ontario water works, west of the mouth of the Genesee river and some three miles from this proposed outlet—

(a) More deleteriously than under existing conditions of discharge of raw sewage into the Genesee river?

(b) In general to such an extent, assuming ordinary operations of the filter plant, so as to be a menace to this supply?

10. Will any pollution derived from the discharge of the effluent of the proposed disposal works—

(a) Ever reach the water intake of the Oswego supply, taken from the lake some 50 miles distant, just west of the mouth of the Oswego river?

(b) If it should ever reach the intake under unfavorable conditions of wind, would the pollution be—

(1) Less in amount and frequency than would occur from pollution carried from the polluted Oswego river and the sewers of the city of Oswego?

(2) In such amounts and with such frequency, that, independent of other pollution, it would appreciably affect the potability of the Oswego supply?

11. If the proposed plans are insufficient, should additional purification be accomplished—

(a) By removing danger to health by disinfection or sterilization?

(b) By increased oxidation or nitrification through biological filtration?

(c) By double protection obtained by biological filtration and disinfection?

12. In view of the fact that the Genesee river below Rochester will not be potable after the execution of the proposed plans, and cannot be made so because of the pollution

which must directly or indirectly reach the river during its course, should only such purification be required as will guarantee freedom from any nuisance or any effect upon the senses?

13. Judged in the light of the broader problem of Great Lake pollution, and the establishing of a general policy concerning the requirement for sewage purification, in connection with not only the city of Rochester, but of other cities and municipalities along the Great Lake system, are the proposed plans in their present form, or a somewhat modified form, sufficient and appropriate; and in your opinion should they be approved by the department either unconditionally, or upon certain conditions and what?

The report of the engineers consulted was a general approval of the plans as submitted. Mr. Horton, however, suggested that the plans be changed so as to provide settling tanks of twice the capacity shown by the plans, together with changes in other minor details of the plans. The commissioner approved of the recommendations of the engineer, and returned the plans for the changes suggested.

Further consideration was given to the matter, and instead of doubling the capacity of the detritus tanks, which would have resulted in mixing sludge with the heavy material for which the detritus tanks were planned, it was decided to add sedimentation tanks. These tanks were designed to be 150 feet long, 25 feet wide and contain an average depth of liquid of 6 feet, and to provide for a period of 30 minutes detention.

It was proposed to construct a set of six tanks at the present time, the number to be increased from time to time as the population of the city grows. It was also intended that the aperture of the screens be increased to 1/8 inch.

The plans as changed were again submitted to the State Commissioner, and finally approved on September 23, 1910.

The plans referred to were designed for a future population of 275,000. This estimate was based upon the growth of the city prior to the year 1905, as shown by the census reports.

The results of the 1910 census showed that the rate of growth was very much in excess of that shown by the preceding enumerations, consequently the estimates of the future population were revised and the plan of the works as now constructed is based upon a future population within the city of 400,000.

It is estimated that 10,000 will reside in what is known as the Brighton District to be served by a system of separate sewers and an independent treatment plant. It is also assumed that the sewage of a population of 48,000 in territory adjacent to the city will eventually reach the main plant.

The original plan was also based upon a water supply of 100 gallons per capita daily. The revised plans provide for a per capita use of 120 gallons.

The disposal of the sludge from the sedimentation tanks was a very serious problem. The city acquired on the lake short an area of about 290 acres of land. This area adjoined the city's lakeside park known as the "Durand-Eastman Park," having an area of nearly 500 acres. It was extremely desirable therefore that the disposal plant should be constructed so as to avoid a nuisance on any part of the newly acquired territory.

Further investigations satisfied both the city engineer and Mr. Kuichling, the consulting engineer, that the tanks recently installed in the Emscher District in Germany, known as the Imhoff tanks, provided a sludge that could be disposed of without appreciable nuisance.

After an extended study of these tanks, and several consultations with Dr. Imhoff himself, it was decided, with the approval of the mayor, to substitute Imhoff tanks for the plain sedimentation tanks. The plans were therefore amended and again submitted to the State Commissioner of Health, and were approved by him in January of this year.

Previous to this approval, however, Prof. George C. Whipple, Professor of Sanitary Engineering in Harvard University, and probably the foremost sanitary engineer in matters of water and sewage treatment in this country, was retained to

investigate and report upon the conditions of the lake and river, and Irondequoit Bay. The analytical work involved in the investigation was carried on by two of his associates at Harvard University, Mr. Melville C. Whipple and Dr. J. W. M. Bunker, in co-operation with Prof. Charles Wright Dodge of the University of Rochester, who generously provided all needed facilities at his laboratory at the university.

Prof. Whipple, in an elaborate report dated October 31, 1912, concurred in the change of the sedimentation tanks to the Imhoff type, and said in conclusion:

"As a conclusion from the results of the studies made during the past summer, I concur in the opinion of the State Department of Health and of the consulting engineers who have investigated the subject in the past, that the disposal of the sewage of Rochester in the manner proposed is the one that best meets the demands of the situation.

"As a result the Genesee river below the city will be restored to its natural use as a public park; the quality of the lake water at the intake of the Rochester and Lake Ontario Water Company will be improved; the water at the beaches near the river mouth will be very materially improved; and the sanitary quality of the water along the beaches at points nearer the sewage outlet will not be impaired.

"I recommend, however, that the plans be modified by the substitution of an improved method of sedimentation, and that a plant for disinfecting the effluent be installed and kept in readiness for use in case subsequent examination shows it to be desirable.

"I recommend further that after the new works shall have been put in operation, a series of observations similar to those made during the past summer be again made in order to show whether the results expected of the process of sewage treatment are attained."

In April of this year, and prior to the award of the contract for the disposal plant, the experimental plant at Elmhurst, Borough of Queens, for the electro-chemical treatment of sewage under process of C. P. Landreth, was investigated.

In view of the fact that the system as planned was practically completed, with the exception of the treatment plant, and to the further fact that the new system was untried in practical use, it was not deemed advisable to longer delay the construction of the plant as planned.

It may be stated that the construction of the Imhoff tanks was delayed for over a year in order to study the operation in this country.

The system of disposal as now nearing completion consists of an intercepting and outlet sewer taking the sewage from all sewers now emptying into the Genesee river. This sewer is planned to take care of a future population of 390,000 on the combined system and 48,000 additional on the separate system.

At the end of the intercepting outlet sewer six parallel detritus tanks are provided, each 90 feet long, 10 feet wide and 4.4 feet deep below dry-weather flow line. These tanks are provided at the entrance with coarse racks and the lower end with mechanically-cleaned screens with ½-inch opening. The average cross-section of the channel when half filled with detritus will be 29 square feet under dry weather conditions. When carrying storm-water the surface will be 2.94 feet higher and the average cross-section will be 58.8 feet. The velocities through this tank will be 0.95 feet per second for dry weather flow and 0.64 feet per second for storm-water.

Following the detritus tanks two main effluent channels lead down between symmetrical groups of Imhoff tanks. There are 20 units in the Imhoff tank installation together with the sludge beds and appurtenances. Each unit consists of a tank 110 feet long and 35 feet wide inside with 35 feet total depth of sewage. Settling chambers with sloping bottoms are two in number each 10 feet wide, with a cross-section of 173 square feet varying from 193 square feet at high water. Each channel has two slots 7 inches wide. Three longitudinal gas vents of an area of 24 per cent. of the entire tank. The sludge compartment, exclusive of the three hopper-shaped pockets in the bottom, and of a 4-foot stratum below the slots, is 11 feet deep

and contains 40,000 cubic feet for each unit, or at the rate of 2 cubic feet per capita.

The flowing-through time for the dry weather flow is about 73 minutes, and for the storm flow 26 minutes. The quantity treated is based upon 120 gallons per capita for dry weather flow and 420 including storm-water in the combined system, and 175 gallons per capita in the separate system. The estimated cost of the completed works is two and one-quarter million dollars.

It should be stated that the changes in the original plans providing for a more complete treatment of the sewage before discharging into the lake were made very largely as a result of the general feeling in the community, as shown by a resolution adopted by the Chamber of Commerce in 1910, which reads:

"It is the sense of this meeting that the authorities of the city of Rochester secure the best expert advice before adopting any final plans for the disposal of the city's sewage. Their action should not be based upon the minimum in dollars and cents, but the health of the people should be taken into consideration, and should be fully conserved not only for the present but for the future."

In the long continued study and investigation resulting in the adoption of the final plans, I wish to acknowledge the intelligent and common sense methods used by the state authorities and by the mayor and common council, and other members having to do with the approval of the plans and the appropriations for carrying on the work.

DISCUSSION.

MR. MILLER: The use of the sprinkling filter was not included in this design?

MR. FISHER: No, not in the main plant.

MR. MILLER: Was that because a greater degree of purification was not necessary?

MR. FISHER: Yes. The consulting engineers thought a sufficient degree of purification would be obtained by the fine screening and the detritus tanks, without further treatment; but the Imhoff tanks were added.

CONVERTING AN OLD SEPTIC TANK INTO A MODERN TWO-STORY TANK.

By ALEXANDER POTTER, *Consulting Engineer, 50 Church Street, New York City.*

There are a number of sewage disposal plants in this country of comparatively recent construction which no longer meet the demands placed upon them by the rapidly growing community which they serve and the more and more exacting demands of sanitation. Many of these plants were built at a time when the engineering profession had little to guide them as to the large quantities of ground water which in certain localities are apt to enter the sewers and sewage disposal plant. Many of the plants are greatly overloaded and badly in need of extension. To extend them to meet the increased sewage flow due either to the rapid growth of the community or to the large quantities of ground water reaching the plant but not provided for in the original design, runs up into large sums of money which many of the communities cannot afford to spend. The author has found that such extensions can often be very economically made by completely remodeling such plants to adapt them to the growing needs of the municipality. This article describes in some detail how a municipality in South New Jersey has solved the problem of extending its sewage disposal plant by completely remodeling it.

ORIGINAL PLANT.

The sewerage system and sewage disposal plant of Moorestown, New Jersey, were designed and built by the writer in 1901. As originally constructed and operated, the disposal plant consisted of a grit chamber 10 feet square and 10 feet deep. It was expected that this chamber would be cleaned out

periodically but it was actually cleaned out about once a year. From the grit chamber the sewage entered an open septic tank which consisted of an uncovered brick chamber 75 feet long, 25 feet 6 inches wide and with an average depth of 7 feet. Two 20-inch brick walls divided it into four equal compartments arranged so that two, three or four of the chambers could be used at any one time. The last compartment was used also as a dosing chamber, the supernatent liquid in the upper four feet of this chamber being automatically discharged by two 8-inch siphons on to the contact bed.

The contact bed was divided into four units, each 85 feet by 42 feet in area. Each unit was embanked with 16-inch brick walls. The natural soil, of a clayey nature, formed the bottom of the bed. Three of the beds were filled to a depth of four feet with slag ranging in size from ¾ inch to 1½ inch; the fourth bed was filled with cinders. The distribution on to the contact bed of the effluent from the septic tank was accomplished by means of a system of open-joint sewer pipe ranging in size from 10 inches to 8 inches and imbedded up to its horizontal diameter in the filter material. Each unit was underlined by a system of vitrified sewer pipe laid with open joints and ranging in size from 6 inches to 10 inches. Four 10-inch pipes conveyed the effluent from the four units to a common valve chamber, about 45 feet away. In this chamber were located the four effluent control valves. A 15-inch vitrified pipe conveyed the effluent from this chamber to the edge of Pensauken Creek, a small stream tributary to the Delaware river.

Early Operating Conditions.

For a period of several years after its construction the plant was virtually allowed to take care of itself. This is not an unusual condition in small towns; in fact, the indifference of municipalities, large and small, as to the proper care of such improvements costing large sums of money is most surprising and is one of the worst evils the consulting engineer has to fight. This condition was permitted to exist in Moorestown

notwithstanding the fact that the Chairman of the Township Committee was a physician of more than local reputation.

Original Plant Overtaxed.

The plant as built in 1901 was designed to treat from 200,000 to 250,000 gallons daily based upon a retention period of eight hours in the septic tank and an average rate of 600,000 gallons per acre per day for the contact bed. Since its construction in 1901, the sewer district grew very rapidly and the capacity of the plant became overtaxed.

In March of 1911 the State Board of Health made an inspection of the plant and found it to be treating a flow of about 500,000 gallons daily. On this basis the total calculated storage in the septic tank was four hours. As the fourth unit of the septic tank was at that time used as a dosing chamber, and as the tanks were also partially filled with solids, the actual storage was but a fraction of this amount as ascertained by tests made by the State Board of Health. Uranine placed in the sewage at the inlet to the plant appeared in the effluent of the filters in just one hour. The net rate on the filters, including the periods of rest, was at this time 1,250,000 gallons per acre per day. The flow was so great that the automatic siphons for dosing the contact beds intermittently were unable to handle the flow during the day and did not break except at the time of light flow during the night. In spite of this tremendous overload, it is the remarkable fact that analyses made on two separate days showed considerable oxidation, and a series of hourly samples taken on the 7th of March were found to be non-putrescible up to the sample taken at 4:30 p. m.

In view of the overloaded condition of the plant, the State Department of Health ordered the enlargement of the plant in 1912. The following summer the people of Moorestown voted $30,000 both for extensions to the sewerage system and for the enlargement of the sewage disposal plant. This amount was determined upon before the services of an engineer were secured and plans of any sort prepared. Of the total amount

PLAN OF REMODELLED SETTLING TANK

FIG. 1

voted, $15,000 was to be devoted to building sewers, leaving only $15,000 available for sewage disposal purposes, irrespective of what the true needs of the case might require.

With an unlimited appropriation, design in the majority of cases is not difficult. With an inadequate appropriation, it is often necessary to resort to expedients which at times develop interesting results.

Two Plans Considered.

With the view of increasing the capacity of the plant, two alternate plans were considered, the one suggested by the State Board of Health to double both the septic tank capacity and to increase the area of the contact bed, and the other, to remodel the existing septic tank into a modern two-story settling tank and to change the existing contact bed over into sprinkling filters. Further investigation showed that the existing contact bed was more or less clogged and needed overhauling. The disposal of the sludge from the existing settling tank also had become an appreciable nuisance, all of which pointed to the advisability of remodeling the plant. Therefore, the latter plan, contemplating the remodeling of the plant, was adopted as being not only the more sanitary, but the more economic one in the end.

Remodeled Plant.

The plant as remodeled is of more than usual interest to the profession in that it shows that a disposal plant consisting of a septic tank and contact beds—a combination used extensively in this country a decade or more ago—can be readily remodeled into a modern two-story settling tank and sprinkling filter at a substantial saving in cost.

Settling Tank.

The remodeled tank is shown in figures 1, 2 and 3, the new work in solid lines and the old work in dotted lines. Figure 1 is a general plan; figure 2, a transverse section; and figure 3, a longitudinal section of the remodeled tank. The work of

TRANSVERSE SECTION B-B

FIG. 2

LONGITUDINAL SECTION A-A

FIG. 3

remodeling consisted in removing the existing bottom and excavating to an additional depth of 2 feet 4 inches. As the new bottom is carried below the foundation walls of the old tank it was built in the form of an arch to give the necessary stability to the walls and to assist in the removal of the sludge. In the old septic tank the level of the liquid was maintained at an elevation of 15 feet above sea level. In the remodeled tank this was raised to elevation 15.5, necessitating the raising of the outside walls a height of 6 inches. These changes increased the depth of the tank from 7 feet to 9.5 feet.

The remodeled tank consists of four units each of which is again divided into three compartments by a false bottom constructed of 2-inch creosoted yellow pine. This false bottom makes a slope of 40 degrees with the vertical. The two upper compartments are settling compartments and the lower and larger compartment is the sludge digestion compartment. The total settling capacity amounts to a retention of 1.35 hours when the plant is operated at the rate of 500,000 gallons daily. The total capacity of the sludge digestion chamber figured below the level of the walls is 5,470 cubic feet, about 50 per cent. larger than required by the established practice. The general arrangement is clearly shown in figure 2.

Three 6-inch sludge pipes extend down into the sludge digestion chamber of each unit. All the sludge pipes are connected to a common 8-inch cast iron sludge drain, the general arrangement being that shown in figures 1 and 3.

The system of distributing the sewage to the various units is of interest as it possesses not only flexibility of operation but also is very efficient in preventing disturbances from currents and vortex motion in the settling compartments.

After leaving the remodeled grit chamber, the sewage enters the main distributing trough, a concrete rectangular channel built directly upon the existing wall of the settling tank. This channel extends the entire length of the basin. Extending across the tanks are four lateral rectangular troughs, each 15 inches wide and 2 feet deep. These lateral troughs can be

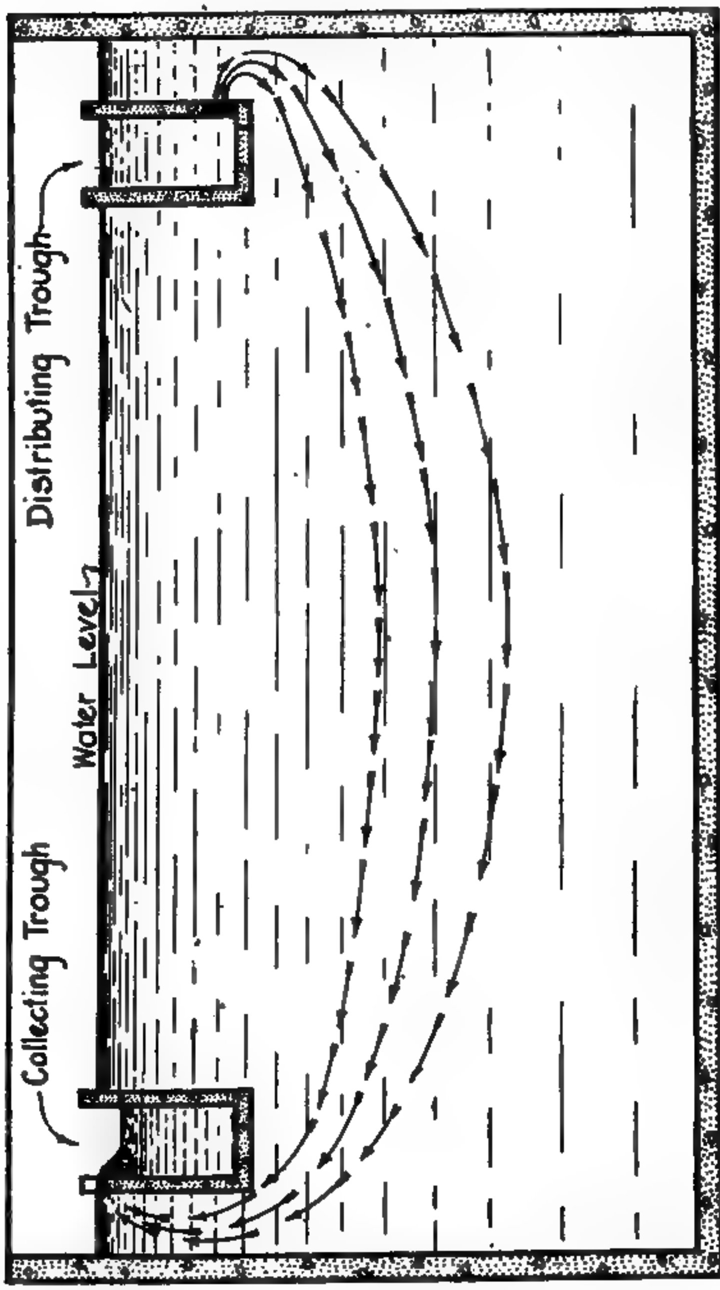


Fig. 4. Method of leading sewage into settling compartment and collecting settled sewage.

used either as distributers or collectors. For this purpose each of the lateral troughs is provided with shear gates at either end so as to regulate the direction of the flow.

Attention is called to the method used of leading the sewage into the settling compartment. This method is illustrated diagrammatically in figure 4, the liquid entering the basin in the direction opposite to that it must take in traversing the basin. This method has proven to be very effective in arresting vortex motion by impinging the inflowing current against the wall of the basin. The collecting trough acts as a scum board and tends to prevent floating matter from being carried out with the effluent. In each unit the direction of flow can be reversed by the simple process of closing two shear gates and opening two others. Reversing the flow at periods of about a month tends to the more uniform distribution of the sluige in the sludge digestion chamber.

Six transverse concrete walks, each 3 feet wide, give the operator ready access to all parts of the tank. Except for these walks, the top of the tank is entirely open.

Wooden covers are provided for the main distributing channel and the main collecting channel so that during the winter months these channels can be covered to prevent the freezing of the sewage at the dead ends.

Sludge Disposal.

An 8-inch cast iron pipe conveys the sludge from the tank to the sludge bed the surface of which is 5.5 feet below the water level in the settling tank. Unfortunately, this sludge bed had to be located about 200 feet away from the settling tank and a closed conduit used to convey the sludge from the tank to the bed. There are several objections to a closed conduit for conveying sludge from an Imhoff tank to the sludge bed, the principal one of which is the difficulty of controlling the character of the sludge discharged and the large quantity of water required to flush out the sludge piping. To prevent the clogging of the sludge drain, provision is made so that the

sludge pipe can be flushed out with settled sewage after every use.

CONTACT BEDS.

Instead of increasing the area of the contact beds to take care of the additional flow and to put them in proper condition, it was found more economical to remodel the beds into sprinkling filters. The original beds were only 4 feet deep, a depth which is not sufficient for an efficient sprinkling filter. It was, therefore, decided to excavate the bottom of the beds from 6 to 12 inches below the bottom of the old contact beds and to bring the finished surface of the sprinkling filter 6 inches above the level of the old bed. This gave a depth of filtering material ranging from 5.5 feet over the main drain to 5 feet at either side. It was found that the maximum head available to operate the nozzles was about 4 feet 9 inches. A circular type of nozzle was used which was spaced 10 feet 4 inches on centers in rows spaced 9¾ inches apart. To reduce the frictional losses in the siphon and piping system to the minimum, the siphon was made 24 inches in size—somewhat larger than customary. The main distributer and all piping were made of ample size so as to keep the frictional losses, even when the plant is extended in the future, within 6 inches.

The nozzles were furnished by the Pacific Flush Tank Company, and are provided with adjustable orifices. Adjustable orifices, although not generally used except for experimental purposes, are of value in such a plant in that the operator can curtail the discharge from those nozzles over any portion of the bed where a tendency to pool and clog exists. This adjustable orifice has proved of value for when the plant had been in operation several months, an area about 10 feet by 25 feet in extent, over which the teams traveled in placing the filter material and which had been compacted by traffic, commenced to pool. This tendency was quickly remedied by throttling the nozzles which discharged over this area, thereby doing away with the tendency to pool.

Because of the limited funds available, and in view of the

clayey nature of the subsoil, it was decided to place the filtering material directly upon the subsoil. The underdrain system of each unit consists of a central concrete channel 15 inches in diameter. Extending at right angles from this channel and spaced 24 inches on centers are lateral drains consisting of 6-inch vitrified bell and spigot pipe laid with open joints. The central drain is ventilated at either end.

Cost of Remodeling the Plant.

The cost of remodeling the plant and enlarging it fifty per cent. to adapt it to the present flow was as follows:

Remodeling septic tank into two-story tank	$3,100
Construction of dosing tank, siphon and piping	1,800
Sprinkling filter, one-quarter of an acre	8,300
Sludge bed and piping	300
Additional piping around plant	1,300
Final settling basin	500
Total	$15,300

The cost of remodeling the contact beds into a sprinkling filter was somewhat more than was expected as it was found that less than 10 per cent. of the filter medium of the original beds could be used in the new filter.

Operation of the Plant.

Almost from the very beginning when the plant was put in operation, the operator experienced considerable trouble with sewage fungi of the Leptomitus type. Masses of sewage fungus reached the plant continuously in such quantity as to completely cover, within twenty-four hours, the surface of the grit chamber 100 square feet in extent with a solid floating mat varying in depth from a few inches to twelve inches. This fungus, because of its tendency to float, passed through the settling basin and dosing chamber and on to the filter bed. The large masses of fungus, sometimes a square foot or more in extent, gave considerable trouble in clogging the nozzles.

Photograph of top of settling tanks showing the floating sludge.

At first the operator tried to improve conditions by inserting a baffle board in the outlet of the grit chamber thereby retaining practically all the fungi and preventing them from reaching the settling basin. This method involved a large amount of labor daily in removing the accumulated masses of fungus from the grit chamber. The fungus thus removed was highly putrescible because of the large quantity of fecal matter which was mixed up with it, and produced offensive conditions around the plant. At the suggestion of Mr. Francis E. Daniels, Director of Water and Sewerage Inspection, New Jersey State Board of Health, an open channel was constructed connecting the grit chamber with the sludge digestion chamber, through which the floating masses of fungus accumulating in the grit chamber could be pushed into the sludge digestion chamber. This method, although a material improvement on the method first used by the operator, was not entirely successful because of the large quantity of fungus that had to be handled daily.

A thorough inspection of the town sewers showed that the sewage fungus grew in great abundance in the main outlet sewers and the laterals. Except for the fungus growth attached to the wetted perimeter of the pipe, the outlet sewer was found to be quite clean because of the high velocity of the sewage, amounting to from 2 to 3 feet per second. This condition was not found to be the case in the laterals and the upper end of the outfall sewer where the velocity was about 1½ foot per second and where the sewers were more or less unclean. All along the trunk sewer and in the laterals the growth of the fungus was so luxuriant that in many cases it completely covered the wetted perimeter of the sewer, not only where the flow was less than 2 feet per second but also in the lower portions of the outfall sewer where it reached from 3 to 4 feet per second. Large masses of this sewage fungus were constantly becoming detached from the sides of the sewers and were reaching the plant continuously in enormous quantities.

Remedial steps were taken to abate this nuisance, by flushing the sewers from the fire hydrants. Enormous quantities of

fungus were thus dislodged and flushed out. The treatment has been quite effective and very little, if any, Leptomitus is now reaching the sewage disposal plant.

Sludge Trouble.

Considerable trouble has also been experienced in operating the remodeled plant, from floating sludge. It is the author's opinion that this trouble is not peculiar to the Moorestown plant but is experienced more or less generally in connection with the operation of all two-story settling tanks, differing only in degree. After the Moorestown plant was placed in operation it appeared that the gas ebullition in the digestion chamber produced a very thick scum. The suspended matter in the sewage which had settled into the digestion chamber was lifted to its surface by the active gas ebullition and kept there. On reaching the surface it was matted together by means of paper, hair, fat and to some extent by vegetable molds, producing a tough floating mass which reached after several months a depth of three feet or more. As the surface of the scum became weathered, the escape of the gases of decomposition was further retarded thereby aggravating the condition.

When the surface of the scum was lifted more than twelve inches above the water line and there was danger of it overtopping the walls of the tank, the operator was instructed to break up the compacted sludge by means of a long-handled rake worked up and down through the scum, thus liberating the gases which were giving the mass its buoyancy. This operation was only partially successful. Although the sludge when properly broken up settled back to the level of the liquid, within forty-eight hours it had regained its original position and the process had to be repeated.

As this method involved considerable labor and had to be frequently repeated, another method was tried. In the operation of septic tanks it has been noticed that rain falling upon scum in an open tank tends to break it up and causes a large

portion of the floating matter to sink to the bottom of the tank. The experiment was, therefore, tried of sprinkling the surface of the scum with settled sewage, no water being available at the plant. The water thus applied softens the crust which has formed on top of the scum, giving the gases of decomposition which have collected in the mass a chance to escape. Furthermore, it seems to increase the specific gravity of the floating matter sufficiently to cause it to settle. Even with the application of water, a certain amount of stirring has been found to be of value.

At the Moorestown plant the area of the sludge digestion chamber exposed to the atmosphere is approximately 28 per cent. of the surface of the settling compartment. It is the author's opinion that the smaller this ratio the more serious will be the trouble from floating sludge on account of the smaller surface from which the gases can escape. The author would like to have the opinion of those members who have had experience with the operation of two-story settling tanks, especially with tanks where the surface area of the sludge compartments bear a much smaller proportion to the area of the tank than at Moorestown.

Operating Results.

The following table gives the average analytical results of samples of sewage taken at the Moorestown sewage disposal plant, by the State Board of Health:

AVERAGE ANALYTICAL RESULTS OF SAMPLES OF SEWAGE, MOORESTOWN, N. J.

(Expressed in Parts Per Million.)

Nature of Determination.	Raw Sewage*	Grit Chamber Outlet	Tank Outlet	Sprinkler Effluent	Final Effluent
Turbidity	220	220	147	30	25
Total solids in suspension	15	17	5	11	11
Fixed solids in suspension	4	3	2	6	4
Loss on ignition	11	14	3	5	7
Organic nitrogen	30.0	49.9	43.3	33.3	31.1
Nitrogen in solution	23.3	36.6	34.4	28.3	28.2
Nitrites	0.040	0.113	0.119	0.227	0.228
Nitrates	0.08	0.45	0.39	2.63	2.90
Free ammonia	15.00	13.07	13.07	8.18	6.90
Oxygen consumed in solution	52.30	40.13	30.80	16.23	12.29
Oxygen dissolved	*....	0.85	0.87	5.87	5.72
Chlorine	33	40	36	34	31

*Determination made only on one day.

Three separate determinations were made by the State Board, one on May 12th, one on June 4th, and one on September 10th. Composite samples were taken on those days at half-hourly intervals covering the period from 11 a. m. to 2:30 p. m. Only one determination was made on the character of the raw sewage, namely, on September 10th.

Considerable sedimentation takes place in the grit chamber, far more than is indicated by the above table, as the sewage on September 10th was considerably weaker than that taken on the other two days. It appears that the grit chamber is entirely unnecessary and should have been abandoned when the old plant was remodeled. Its continued use entails considerable work upon the operator in removing the large quantities of heavier suspended matter which settle out of the sewage in the grit chamber.

The plant yields an unusually clear effluent, free from sediment and very low in turbidity. The oxidation in the filters is

very complete. Tests show the effluent to be non-putrescible during the greater part of the time.

DISCUSSION.

MR. WESTON: Have you drawn off any of the sludge? And what was the character of the sludge drawn off?

MR. POTTER: Yes; the sludge was drawn off at intervals, and it compared very favorable with the sludge from the best examples of Imhoff practice in the United States. It was free from odor, save the slight musty odor which is present in all Imhoff sludges.

MR. CARPENTER: What were the lowest temperatures as far as your knowledge goes, under which sprinkling filters were operated in this country?

MR. POTTER: I know of their operating at 10 degrees below zero.

MR. CARPENTER: Was the spacing of the under-drains similar to the spacing of the under-drains at the Springfield, Missouri, plant, which you mentioned last year?

MR. POTTER: They are closer in this new plant somewhat, for the reason that we omitted the smooth concrete floor and placed the under-drains directly upon the ground, requiring in my judgment a closer spacing than was necessary when we had the solid concrete floor.

MR. CARPENTER: Have you suceeded in breaking up that scum?

MR. POTTER: By keeping it wetted down, we get rid of it pretty well. It takes 15 or 20 minutes to go over it with a sprinkling can every day, and that keeps it so that it does not form to the same depth as otherwise. There is a deposit on the top, but we have increased the specific gravity of the sludge and it precipitates much more readily than before we adopted that method. That could be more promptly done with a water supply, but most sewage disposal plants are in isolated places, and a water supply in a small plant is usually not available.

THE MILWAUKEE SEWERAGE PROBLEM.

By T. Chalkley Hatton, *Chief Engineer of Sewerage Commission, Milwaukee, Wis.*

Like all other large cities of the United States the city of Milwaukee has its sewerage problem, the solution of which has given its thoughtful citizens grave concern for many years, and several of the leading engineers of this country have been engaged from time to time to give advice upon the subject.

In 1876 the Board of Public Works of Milwaukee, of which Mr. George H. Benzenberg, Past President of the American Society of Civil Engineers, was chairman, reported upon the dangerous pollution of the rivers flowing through the city from the sewage being discharged into them. This report was followed by the employment in 1878 of an Engineering Commission, composed of Messrs. E. S. Chesbrough, Moses Lane and George E. Waring, to study and report upon the best method of preventing this pollution. The report recommended a system of intercepting sewers alongside of two of the rivers, which recommendation was partially carried out from 1880 to 1886.

In the latter year Mr. Benzenberg recommended that the Milwaukee river be flushed with a large volume of water pumped into it from Lake Michigan by means of low lift screw pumps. This recommendation was carried out under his supervision in 1888.

In 1889 a commission, composed of Messrs. Benzenberg, T. J. Whitman, Joseph P. Davis and Henry Flad, submitted another report upon the sewage problem. Following this the Kinnickinnic river flushing works were built to prevent its pollution from the sewage being discharged into it.

In 1909 a commission, composed of Messrs. John W. Alvord,

George C. Whipple and Harrison P. Eddy, was created to study the whole problem of collecting the sewage from the sewers already built and finally disposing of it. This commission made its report in 1910, following which the State Legislature of 1913 passed an act authorizing the creation of a Sewerage Commission composed of five citizens to study the problem and to carry out such works as were found necessary for its solution.

Thus, for thirty-eight years this question has been energetically studied by citizens and engineers, and a large sum of money expended in alleviating the troubles as they arose, but prior to the creation of the present Sewerage Commission, no such broad powers had been granted the city which would enable it to carry to a conclusion all the works recommended.

The present Sewerage Commission consists of Mr. George H. Benzenberg, chairman, one of the leading civil engineers of the United States, and Messrs. Michael Carpenter, Conrad Niederman, Theodore O. Vilter and George P. Miller, Esq., all leading citizens and successful men in their several lines. They were all appointed by his honor, Dr. G. A. Bading, the present mayor, who, as Commissioner of Health for the city, had closely followed, or rather led, the movement for better sanitary conditions in the rivers and lake, and, therefore, realized the importance of forming a commission consisting of men broad enough to thoroughly grasp and solve such a problem.

There are three conditions under which this commission is working, which are somewhat unusual, but which are necessary to insure success in all undertakings of this character.

Its members are appointed to hold office during the entire period it may require to carry out such work as may be planned. The funds necessary to carry out the work must be provided by the city council by a special levy of taxes upon real and personal property up to an annual limit of one mill of assessed valuation of such property. The expenditures made are solely under the direction of the commission, subject to the approval of the City Comptroller. The commission employs

all assistance needed, subject to the civil service rules of the city, and fixes all salaries with one exception. The rate of salary of its Secretary must be confirmed by the City Council.

The responsibility for properly and satisfactorily solving this problem is thus put squarely up to the Sewerage Commission, as it should be, and it is the only method by which public works of a special character can be carried out satisfactorily to the citizens of a community.

The city of Milwaukee is located upon the west shore of Lake Michigan, about 85 miles north of Chicago. The city has been built around the mouths of three rivers, of which the Milwaukee river is the chief, and which flows directly into Lake Michigan. The Menomonee and Kinnickinnic rivers join the Milwaukee river near its mouth. These three rivers spread out through the city like the three fingers of a hand. The Milwaukee river flows through the northeastern section of the city, the Menomonee flows almost due east from the west, and the Kinnickinnic from the southwest towards the northeast.

Each of these rivers is navigable for about two or three miles from its mouth for boats drawing from 18 to 20 feet of water, and all are partially bulkheaded as far as navigation extends. Several slips or inner docks have been built in the Menomonee and Kinnickinnic valleys, and a dam across the Milwaukee river about three miles above its mouth.

The drainage areas of the three rivers are approximately 872 square miles, of which the Milwaukee has 715, the Menomonee 125, and the Kinnickinnic 32. The estimated average run-off of these rivers in gallons per 24 hours is as follows: 221,000,000 in Milwaukee river, 57,000,000 in Menomonee river, and 15,000,000 in Kinnickinnic river, while the minimum flows have been estimated to be 2,000,000 from the Milwaukee, 1,300,000 from the Menomonee, and 650,000 gallons from the Kinnickinnic river.

There being no ebb and flow of tide in the lake, under minimum flow conditions there is very little current in the rivers

except such as is occasioned by wind action upon the waters of the lake.

The average water consumption at the present time is about 48 million gallons per day. Assuming the water consumption to be equal to the sewage run-off, as is so frequently the case, and the sewage being discharged into these three rivers within the city limits, it takes no great elasticity of imagination to picture the sanitary conditions of these rivers under such an assumption.

The valleys of the rivers are narrow, and are from 6 to 20 feet above the level of the water. The large part of the present business and industrial sections are located in these valleys, while the domestic areas are located upon the table lands which rise to a height of 160 feet above lake level; the natural drainage being excellent and falling away from the lake.

The increase in population of the city of Milwaukee since 1850 has been very rapid, although at a fairly uniform percentage, indicating no boom but a substantial growth. In 1850 the population was 20,000, in 1910, 373,857, while in 1914 the population is 410,000. It is estimated that in 1930 the population will be 588,000 and 862,000 in 1950. There are 26 square miles within the present city limits, and the limits for 1950 will probably contain 59 square miles.

The city is largely industrial, its chief industries being killing and packing meats, the manufacture of leather, engines and machinery, steel, and, last but not least, the production of beer.

The meat killing and packing, leather and beer industries consume enormous quantities of water and produce a sewage which is much more difficult to dispose of than the normal domestic and industrial sewage.

The leather manufacturers use a daily average of 4¼ million gallons, the packing houses one million, and the breweries six million gallons, which does not include the water taken from wells and rivers into these plants, which is an additional large amount.

The foregoing data and description have been given as briefly as possible to permit of a better understanding of the problem involved in collecting and disposing of the sewage of the city.

The city of Milwaukee was much more fortunate and far-seeing than most of its neighbors, in that early in its career its officers laid out a complete system of sewers designed to carry off both the sewage and storm-water from a population of nearly one-half million persons. As the growth of the city increased, this system has been extended from time to time until it provides for nearly all the present population and embraces about 400 miles.

This system is on the combined plan and carries both storm-water and sewage in the same conduits, which discharge into the three rivers, with two exceptions; these two sewers discharging into the lake in the southeastern part of the city. This system has 75 outlets into the rivers, of which 47 discharge into the Milwaukee river.

The dam across the Milwaukee river, which is about 14 feet high, backs the water up for two or more miles, there being very little current in the river during minimum run-off. Public parks adjoin the river on both sides, the water is used for boating, swimming and other sports; it is, therefore, important that sewage pollution be prevented in this portion of the river.

To this end intercepting sewers have been built upon each side of the river from near the northern city limits to a point below the dam. These sewers are large enough to carry off all the sewage and a large proportion of the storm-water, the balance passing through overflows into the river.

The condition of the Milwaukee river was so unsanitary in 1888 that the city built, under the supervision of Mr. George H. Benzenberg, then City Engineer, a flushing tunnel, 12 feet in diameter and 2,543 feet long, connecting the lake with the Milwaukee river at a point near the toe of the dam. A pumping station is located on the lake end of the tunnel in which a screw pump is located and by which 324 millions of gallons of

lake water per day can be pumped into the Milwaukee river. This pump raises the water from two to three feet, and at the time it was installed, had the largest volumetric capacity of any pump in the world.

This large volume of water, discharging into the river at the head of navigation, not only creates a current towards the mouth but affords sufficient dilution to increase the dissolved oxygen in the river from zero to 6 to 8 parts per million.

This tunnel, and its operation, have been a great success from the start, but the sewage flow has increased so much during the 26 years the flushing tunnel has been in operation that the sanitary condition of the river is again causing great [illegible].

The Kinnickinnic river is flushed by similar works, which discharge the same volume of water into the river at the head of navigation. This tunnel is 12 feet in diameter and 7,185 feet long, and the pump is located at the river instead of the lake.

In order to prevent the pollution of the Menomonee river within the city limits, an intercepting sewer was built in its valley, from the western city limits to Jones Island, which is a low flat strip of ground lying between the mouth of the Kinnickinnic river and the lake. This sewer was built not only large enough to carry all the sewage flow which might otherwise discharge into the river, but of sufficient capacity to carry an equal volume of river water which is admitted into the sewer through four gates connecting the river and sewer at points a considerable distance apart; the idea being not only to flush the sewer by the river water, but to create a current in the river by taking the water out and allowing the lake water flowing down the Milwaukee river from the flushing works to take its place.

At Jones Island a pumping station was built by which the sewage and river water are lifted about ten feet and discharged into the lake near the mouth of the Milwaukee river. This pumping station handles about 45 million gallons of liquid

per day, which has been going into the lake for the past 28 years.

The water supply for the city of Milwaukee is procured from Lake Michigan through a subaqueous tunnel seven and one-half feet in diameter and 3,146 feet long, from the outer end of which two lines of 60-inch cast iron pipe extend 5,000 feet further to a point where the water is 60 feet deep. This intake is about 3.5 miles, on a direct line, from the mouth of the Milwaukee river, where all the sewage from the city is being discharged, and as there is very little current in the lake, and much of what there is is directed by the winds, it can be readily imagined that the water supply is in some danger of becoming pulluted from the sewage. In fact, the possibility is so great that the water used is treated with a sterilizing agent, which so far has proved satisfactory.

The problem which the present Sewerage Commission has to solve is to collect all the sewage which now discharges in the three rivers and lake, both within and without the present city limits, by means of intercepting sewers, carry it to some suitable site where works are to be built for treating it, and carry the treated effluent to some point in the lake where it cannot threaten the purity of the water supply or cause a nuisance to the riparian rights to the lake.

The Menominee Sewerage Commission, consisting of Messrs. Alvord, Whipple and Eddy, presented a very elaborate and well-studied report in 1910, in which it was recommended that the sewage be collected by a system of high and low level sewers, carried thereby to a tract of ground containing about 26 acres, located in the southern portion of the city alongside of the Kinnickinnic river, where it would be given preliminary treatment with grit chambers, screens and sedimentation tanks for the removal of suspended matters, and a disinfecting station, the effluent therefrom to be discharged into the Kinnickinnic river. When this river could no longer provide dilution for sufficient oxidation, the effluent is to be carried by a 13-foot conduit in tunnel to the lake front at a point about one-half

mile south of the present limits, from whence it would be carried through a subaqueous conduit, about one and two-thirds miles from the lake shore, where it would be dispersed into 35 to 40 feet depth of water, through two steel pipes five feet in diameter and 3,000 feet long, built upon the lake bottom. The commission suggested that in order to delay for some years the building of this large outfall tunnel, provision might be made for temporarily treating the sewage by chemical precipitation. It further suggested that Imhoff tanks might prove more advantageous than shallow horizontal-flow well-baffled tanks, and recommended that a careful study be made of the adaptability of these tanks to the conditions in Milwaukee.

If necessity arose subsequently for a more thorough treatment of the effluent from the sedimentation tanks, sprinkling filters were to be built along the lake shore at the junction between the land and subaqueous tunnels. Land being made therefore along the lake front.

The report of this commission left many important points to thoroughly study before deciding upon the final construction, chief of which were the system of treating the sewage, the method of disposing of the sludge, the site for the disposal works and the location and sizes of the intercepting sewers.

As before stated, the system of sewage disposal recommended by the commission was chemical precipitation followed by sterilization.

The site recommended was what is known as the Chase tract, of about 26 acres, located on the Kinnickinnic river and largely surrounded by dwellings and manufacturing industries. The sludge was to be disposed of by hauling to the lake and dumping it therein about ten to twenty miles from shore.

Very soon after this report was made public objections arose as to the method of sewage and sludge disposal. The commission assumed the process recommended would generate about 2,500 gallons of sludge per million gallons of sewage treated, or about 120,000 gallons per day from the present population, 250,000 gallons per day from the probable popula-

tion in 1930, and 500,000 gallons per day from the population anticipated in 1950. The handling of this enormous volume of sludge by steamer to a point ten to twenty miles in the lake looked like a large item of daily expense; but aside from this, it was feared that the present international agitation against the pollution of the waters of the Great Lakes would finally result in estopping the city of Milwaukee from thus disposing of its sludge, whereupon other treatment and other disposition would have to be resorted to, and as there was no waste land in the vicinity of the Chase tract upon which the sludge could be deposited without nuisance to neighboring property rights, it was deemed expedient to make a careful and exhaustive study of other processes of sewage and sludge disposal before finally adopting any process.

The chief opposition upon the part of many of the citizens of Milwaukee, however, was to the site chosen for the disposal works. There is a strong sectional feeling in the city, as is usual in all cities of large magnitude, and the "south siders" objected to having the filth of the "north siders" dumped down in their midst, especially as, in their opinion, the topography of the city presented another site for disposal works which would be a menace to no one.

The present Sewerage Commission, therefore, decided to build a testing station to try out those processes of sewage treatment applicable to large installations; to take the raw mixed sewage from the pumping station located at Jones Island as fairly representing the normal sewage to be disposed of in the ultimate plant; to carry out these tests with vigor for twelve months and from the results thus obtained design a sewage disposal plant which would, without any reasonable doubt, best fulfill the conditions for the city of Milwaukee.

This testing station has just been completed and its operation has begun, under the direct charge of Mr. William R. Copeland, Chief Chemist to the Commission, assisted by an assistant chemist, a bacteriologist and an engineer.

The several processes being tested are as follows:

Sedimentation and sludge digestion by means of an Imhoff tank, followed by aeration through sprinkling filters, final sedimentation and the sterilization of the final effluent by means of liquid chlorine.

Sedimentation, aeration and precipitation by means of a slate tank, followed by aeration through sprinkling filters, final sedimentation and sterilizing the effluent.

Chemical precipitation by the injection of iron and lime solutions into the raw screened sewage before passing through tanks, followed by aeration through sprinkling filters, final sedimentation and subsequent sterilization.

Sterilization and precipitation by means of lime solution added to electrolytic treatment.

Fine and coarse screening followed by the several tank and sterilizing treatments.

Tests for sludge disposition by dewatering by means of natural filtration through sand and stone beds, and by means of pressing into sludge cakes.

The apparatus connected with the several processes are arranged to treat a maximum of 1,000,000 gallons of sewage per 24 hours, which is a much greater quantity than is provided for in the usual testing station, but it was desired, when laying out the station, to make the several units of such size as would insure getting representative results.

The Imhoff tank is 26 feet deep and 14 feet in diameter, and provides for a running through period of from 1¼ to 2½ hours.

The slate tank is 22 feet long, 13 feet wide and 6 feet deep, filled with slates spaced ½-inch to ¾-inch apart, standing vertically, and has a liquid capacity of 10,000 gallons. Working in six to eight hour cycles, this gives a capacity of 40,000 or 30,000 gallons per day. Compressed air is provided for the slate tank, and is to be fed to the tank under low pressure, lifting the sewage from the tank through 2½-inch pipes terminating about four feet above the normal sewage level. The sewage, mixed with entrained air, discharges from the end of

these pipes, falls upon a slate roof built over one-half the tank, and flows back into the opposite side of the tank, from which it started; thus the air keeps a constant current in the tank during the five or seven hours the sewage is contained therein, during which time intensified oxidization progresses and the suspended solids in the sewage become attached to the surface of the slates At the end of the cycle the liquor is drawn off and discharged into a tank holding 10,000 gallons, from whence it is discharged, at a uniform rate, upon a sprinkling filter, the sludge being drawn off at desired intervals to a sludge tank, thence into a sludge bed partially filled with crushed stones and fine sand through which a portion of the liquor in the sludge is drained off.

This is practically an untried process and it is expected to reduce the area of sprinkling filters from three to four times what is necessary to treat the effluent from any other preliminary tank process. The process was suggested from experiments conducted for the past two years at the Lawrence Experimental Station of the Massachusetts State Board of Health, under Mr. Harry Clark, Chief Engineer.

The chemical precipitation tanks are in duplicate, 32 feet long, 10½ feet wide and 10 feet average depth, each with a capacity of 25,000 gallons. The iron, alumina and lime solution tanks are so arranged as to permit the solution to be added to the raw sewage after it passes through the screen chamber and be mixed with the sewage before it reaches the tanks.

Each of the processes is provided with separate sludge beds, There are, one for the slate process, two for the Imhoff tank and fourteen for the precipitation tanks. Each of these beds is underdrained and contains about 9 inches of crushed stone, covered with a layer of sand 3 inches deep.

There are three kinds of screens provided: A coarse grid screen with one inch openings placed over the outer end of the intake pipe.

A bar screen with one-half inch openings through which the

sewage passes after passing through the grit chamber, and a movable wire mesh screen, having ten meshes to the inch, moving through the sewage at the rate of 2½ feet per minute.

The first two screens are to be cleaned by hand, the movable screen is to be cleaned by compressed air, blown upon the underside of the screen at a pressure of 100 pounds to the square inch.

All parts of the plant are arranged to enable a close record to be made of every operation. Apparatus for measuring the sewage treated by each process, the amount of electric current used for power, amount of air used at the different pressures, weight of sludge and screenings removed, amount of chemical solutions used and steam consumed can be determined with ease and accuracy.

A laboratory, thoroughly fitted up for carrying on the chemical and bacteriological determinations, has been constructed alongside the plant, and the commission hopes that in twelve months some valuable information will be secured which will advance the science of sewage disposal and enable it to determine the best system for Milwaukee.

Like the testing station built for the Borough of Brooklyn, all apparatus and plant connected with the several processes are built above ground, thus permitting of a much more satisfactory inspection of the processes. This is particularly true of the screens and grit chambers from which it was desired to get most accurate results in view of the recent importance attached to fine screening.

The sewage proposed to be ultimately treated will be from the present combined system of sewers, and the intercepting sewers are being designed to carry about three times as much storm water as sewage; the ultimate sewage disposal plant will, therefore, have to take care of a large volume of the first street wash, containing both organic and mineral solids. In order to measure, and satisfactorily observe, the sedimentation of the grit under such conditions, the grit chambers were built at the top of the operating house, 35 feet above the

ground. The raw sewage, after passing through the rough grid screen placed at the intake end of the suction pipe, is forced by two centrifugal pumps into the grit chamber, which are so baffled as to control the velocity of flow through them. Scales are provided alongside of the grit chambers to measure the grit thus participated.

After passing the grit chambers, the sewage can be turned upon either the fine movable screen or the secondary grid screen, or upon both, from whence it flows through orifice boxes to the several processes, the waste, if any, passing through an independent orifice box.

The use of compressed air for cleaning the screens was tried out with much success in the Chicago stockyards, and it is to be tried out here with every apparatus necessary for measuring its cost under different processes and volumes.

All of the moving parts of the plant are operated by electric current generated by two 25 K. W. D. C. generators, built in the main sewage pumping station. Steam lines for heating the buildings and the several tanks exposed, have been run throughout the works securing the steam from the three boilers in the main pumping station.

A weir, 20.35 feet long, has been built across the wooden channel which carries the sewage from the main sewage pump and over which from 30 to 50 million gallons of sewage per day passes, and an automatic liquid recording gauge has been set up to measure the total flow for the purpose of determining at all times the proportion between the total sewage pumped by the main works and the sewage treated in the testing station.

The total population contributing to the main pumping station has been taken, the volume of water consumed and runoff per capita secured; the total industrial and commercial runoff per acre has been measured and the analysis made of the effluents from the principal industrial plants contributing to the sewage station.

This information could all be obtained with more than

average accuracy as all water consumers connected with the public water supply are metered. In addition to this we have maintained for several months liquid recording gauges upon some of the larger main sewers by which means we have secured good records of runoff.

It might be interesting to here note that we had one very unusual situation by which we could determine with unusual accuracy the ratio between runoff and consumption. A sewer 96 inches in diameter at its outer end drains a section containing 1,530 acres and 62,600 persons. There are no industrial nor commercial uses for the water in this district, it being purely domestic, completely built up, with an average of 50 persons per acre, excluding streets areas.

Upon plotting the curves of runoff and consumption for the same day of the week and for several consecutive weeks, a curve showing the underground leakage flowing through the main sewer has been clearly deduced. Up to date this leakage has diminished from 40 gallons per capita per day in April, 1914, to 15 gallons per day in August. The winter being an unusually open one in this section, followed by an early spring, the underground maximum run off was earlier than usual. During June there were rains during 26 days. The underground flow showed up very decidedly during the records taken, the latter part of June and first part of July.

Studies are now being made and partially completed for determining the sizes and locations of the several intercepting sewers necessary to intercept the dry-weather flow and a portion of the storm flow, and carry it to the disposal works. The plans for the portion of the disposal works to be built in the near future will provide for treating 100 million gallons of sewage; the ultimate works will treat about 158 million gallons.

The intercepting sewers are being designed to carry to the works a maximum of 320 million gallons of liquor, of which over one-half is storm water.

The plan provides for low-level and high-level intercepting

systems. The sewage collected by the low-level sewers must all be pumped about 35 feet high to get it into the disposal works. This represents about one-quarter of the total sewage and storm-water collected, and is collected from the areas lying between contour 30 above the lake level.

This low lying section is largely adjacent to the three rivers; therefore, the low-level interceptors will be built as near the river banks as existing structures and streets will permit. The greater portion of the river banks being bulkheaded, and either used for wharves or have large commercial houses and manufacturing industries built abutting thereupon, the location and construction of intercepting sewers will be attended with much difficulty and expense. Naturally the substrata adjacent to the rivers is not of the most substantial material and will require special foundations. In order to carry the interceptors to the sewage disposal plant the rivers will have to be crossed several times. This will be done by inverted siphons, built deep enough to secure firm foundation, which we have found to be from 60 to 80 feet below water level.

The high-level intercepting sewers will be located to intercept all the dry-weather flow and that portion of the storm-water desired originating above contour 30, and will be extended to the probable limits of the city in 1950. The flow through these interceptors will be carried to the disposal works by gravity.

The design of the main outfall sewer to carry off the effluent from the disposal works has not been begun, but from present indications, it will be a conduit about 13 feet in diameter, part of which will be subaqueous, terminating at a point under the lake where a depth of 30 to 40 feet of water can be obtained. Its location, however, depends entirely upon where the disposal plant is ultimately located and the character of effluent obtained from the process of disposal finally adopted.

Even after the dry-weather flow is intercepted by means of the proposed system of intercepting sewers, great quantities

of putrescible organic matter will reach the rivers during every storm. With the small dry-weather flow through these rivers, the decomposition of this matter might cause them to become a nuisance to the adjacent neighborhood.

To overcome this condition, the Milwaukee and Kinnickinnic rivers have already been provided with ample facilities for flushing by means of the flushing tunnels already built, and which were briefly described at the beginning of this paper. In order to overcome the condition in the Menomonee river it is proposed to build similar flushing works, taking the water from the lake, carrying it through a tunnel of sufficient capacity to carry from 400 to 500 million gallons to a pumping station located along the river bank, there screw pumps would be built to lift this water a few feet and discharge it into the river at the head of navigation, and at the head of the slips connected with the river; the current thus produced in the river would carry all matters in suspension to the lake, and the clear lake water would add dissolved oxygen to the river water and thus assist in its purification before it reaches the lake.

While the approximate cost of building all works necessary to carry out the general plans has not been made, because the studies and plans have not been completed, preliminary studies already completed indicate that the cost of building the intercepting sewers necessary to take care of the expected population in 1930, or 588,000, will be $2,661,360.00; disposal plant, consisting of Imhoff tanks, sludge drying beds and sterilizing plant, $1,188,928.00; pumping plant for low-level sewage, $294,400.00; main outfall sewer from disposal plant to lake shore, $1,209,600.00; subaqueous outfall sewer to deep water, $1,150,000.00; Menominee river flushing works, $1,162,000.00. The last two items are taken from the report of the Menominee River Commission. The total approximate cost so far as now known is $7,666,288.00.

This estimate is based upon using Jones Island as a site for disposal works and installing Imhoff tanks and sterilizing

plant without further treatment except dilution into lake. Subsequent determinations reached from the results of the testing station may change these premises very much, and also the estimates.

It is expected that actual construction upon the low-level intercepting sewers will begin in the spring of 1915, from which time the work will be carried on as rapidly as the necessary funds are provided. The present sanitary conditions of the river should be improved as rapidly as may be possible, and it would appear that sufficient study by eminent men has been given to this problem to insure its proper solution without further delay.

In closing this paper it seems apropos to call your attention to enormous expenditures contemplated in the very near future by the larger cities of the United States for treating their liquid wastes. These expenditures have been postponed from time to time for what appeared to be more urgent public works, such as increased water supply, water purification and improved street pavements, but it is being fully appreciated that the time has come when these closely built up communities can no longer, with safety to themselves, continue to discharge their untreated liquid filth at their front doors.

Boston, Mass., and Providence, R. I., completed works for satisfactorily disposing of their sewage several years ago. Columbus, Ohio, Baltimore, Md., New Orleans, La., and Atlanta, Ga., have recently completed works for treating or satisfactorily disposing of their sewage. Aside from these, no large city of the United States has really undertaken the work, although Chicago carried out works some years ago by which it was then believed its sewage could be properly disposed of, but today Chicago, New York, Cleveland, Detroit, Dayton, Cincinnati, Philadelphia, Rochester and Milwaukee are all studying plans for sewage disposal. Toronto, Canada, is also experimenting with the problem. It is, therefore, apparent that within the next decade the largest sewage works of the world will be constructed or started during which time many new lessons on sewage disposal are bound to be learned and the whole world benefitted thereby.

ECONOMICS OF SEWAGE FILTERS.

By GEORGE W. FULLER, *New York City.*

Types of Sewage Filters—Sewage filters may be divided broadly into three classes:

1. Intermittent sand filters or their equivalent. This consists of a body of sand or fairly pervious material of other kinds. The sewage is distributed over the surface of this porous material, and at the bottom the filtered sewage is collected in underdrains. In order to get the benefit of oxidation in the pores of the sand bed, the application of the sewage to the filter is intermittent with periods of rest and aeration.

2. The second type is the so-called "contact" filter. This consists of a body of practically any thickness of stone or equivalent material, such as large-sized gravel, pieces of porcelain, brickbats, cinders, or almost any coarse-sized granular material. The sewage is applied to such a filter either from the bottom or from the top, so as to fill the bed. The sewage is allowed to stand in this filter bed for a given time. It is then discharged and the empty bed is allowed to stand for a period.

3. The third type is the so-called "sprinkling" filter. This consists of a body of stone of a minimum depth of five feet, on which the sewage is sprinkled or sprayed and spread by nozzles and distributed in small quantities so that the sewage trickles down over the stones and is collected at the bottom.

All three types of filters effect the purification of the sewage in the same way. Thru the action of the bacteria present in the filter bed the sewage is to some extent oxidized and the organic matter is broken up. Unstable forms of matter are changed into more stable forms. While the exact form of action is unknown, it is believed that the three types of filters

act in the same way, and the difference is rather a mechanical one of form of application, rather than one of principle of action.

Performance of Filters—The output of a filter of any type, measured at any suitable purification unit, is largely a question of local conditions. It depends upon the nature of the sewage, the nature and fineness or coarseness of the filtering material, the method of application of the sewage to the filtering material, temperature, atmospheric conditions, and many other factors. The intermittent sand filter is best used when it is desired to have a very high degree of purification. The other types, the contact filters and sprinkling filters, are used for a rather lesser degree of purification. It is to be understood that the rate of application of the sewage to the various types of filters must be properly proportioned to the ability of these filters to take care of the sewage. By using a suitable rate under suitable conditions any type of filter can be made to give any degree of organic purification that may be desired.

Rate of Application of Settled Sewage to Filters—The question of the rate of application of sewage to a sand filter is largely tied up with the question of preliminary treatment in the way of tankage or screens. Quoting from my book "Sewage Disposal," we make the following table for several cities in Massachusetts of the population whose sewage can be treated per acre of filter bed, with the time of detention in preliminary sedimentation tanks, storage wells, pump wells, or other means of storage. These figures are not to be taken to represent present conditions.

	Period of Detention	Population
Andover	1¼-3 hours	950
Brockton	12 "	1,160
Clinton	12 "	425
Framingham	12 "	375
Gardner (Old)	1½ "	1,310
Gardner (New)	1½ "	2,000
Pittsfield	12 "	605
Stockbridge	8 "	220
Worcester	1½ "	1,390
Average of all	6.7 hours	937

The Baltimore Sewerage Commission in 1906 estimated that, using a sand filter with 3 feet of clean sand over the gravel, an allowance of 150,000 gallons of 6-hour settled sewage per acre in 24 hours, corresponding approximately to 1,200 people per acre, would be a proper rate.

Data for contact filters are relatively scant in American practice, and while many English data are available, the differences, owing to the difference in the strength of the sewage, make such data rather dangerous as a basis of comparison.

A series of experiments in Columbus, Ohio, indicated that 5-foot deep stone filters on the contact principle could be safely operated at an average of 600,000 to 700,000 gallons per acre per day. Reducing this to a 4-foot depth will give about 500,000 gallons per acre per day, which, on the basis of 100 gallons per capita per day, would give a loading of approximately 5,000 people per acre of stone bed.

A series of tests made at Lawrence on contact beds of various depths from 24 inches up to 18 feet showed an average output of some 700,000 gallons per acre per day for a depth of stone on an average about 5½ feet. This is equivalent to an output of about 135,000 gallons per acre for each foot of depth of stone, or, for a 4-foot depth of bed again, is equal to about 500,000 gallons per acre per day, or say a loading of about 5,000 people to the acre.

The contact filter installation at Plainfield, N. J., with 3.6 acres of stone bed 4½ feet deep, gave in 1910 an output on an average of 1.7 million gallons of sewage per day. On the basis of an allowance of 100 gallons per capita per day, this will correspond with a 4-foot bed, to about 4,200 people per acre of filter.

For sprinkling filters much more satisfactory data can be had. Sprinkling filters have been used very extensively in this country of recent years and their ratings can be fixed with a good deal more dependence. A list of a number of plants or projected plants giving the depths of the stone bed

of a sprinkling filter and the loading in population per acre follows:

Atlanta	6	feet deep	20,000
Reading	5	" "	18,000
Columbus	5	" "	18,000
Baltimore	9	" "	20,000
Montclair	7½	" "	15,000
Philadelphia	6	" "	20,000
Fitchburg	10	" "	20,000
Mount Vernon	8	" "	24,000

The average of all these shows a 7-foot deep bed and average loading of 19,400 population to the acre.

Not considering special conditions and just taking fair figures, we may safely state the following:

Intermittent sand filters, 3-foot bed of sand, loading 1,000 population per acre;
Contact filters—4-foot depth of stone, loading 5,000 population per acre;
Sprinkling filters—7-foot depth of stone, loading 19,000 population per acre.

The rates, then, for these three types of filters are in the ratio 1, 5, and 9 feet.

Cost of Sewage Filters—Costs of construction are so much affected by local conditions, such as the amount of excavation necessary, the cost of various classes of materials, the distance from which various classes of materials must be obtained, details of local construction conditions, such as competition, class of work required, and others, that comparative costs for different localities are only to be used with great discretion, and individual cost and even averages are only a guide to comparative costs in various places. Having this limitation in mind, we will examine in a rough way the cost of various types of sewage filters on the per capita basis.

The average cost of the nine Massachusetts intermittent sand filters cited above is $3,260.00 per acre, as reported in the Massachusetts State Board of Health Report of 1903. This gives a cost per capita connected to the filters of $3.50.

The 1906 Baltimore Sewerage Commission estimates the cost per acre of filters at $6,350.00, these filters being suitable for a connected population of 1,200 per acre. This corresponds to a per capita cost of $5.30.

The cost of contact filters, varying, of course, with the degree of the fineness of the design, may be taken, for filters equipped with suitable convenient appurtenances, at $30,000.00 per acre for a 4-foot deep bed. This corresponds with a loading of 5,000 population per acre to a per capita cost of $6.

For sprinkling filters 7 feet deep the cost will be about $45,000.00 per acre. On the basis of a loading of 19,000 population per acre, the cost per capita will be $2.37.

When considering the relatively low cost of the Massachusetts sand filters compared with the estimate made from the Baltimore sand filters, it is to be borne in mind that the conditions in Massachusetts for the construction of sand filters were unusually favorable and do not represent average conditions thru the country. In most places the costs would approximate more nearly those estimated for Baltimore.

Taken in a broad way, sprinkling filters are a far more economical installation in the matter of first cost. Intermittent sand filters and contact filters do not stand far apart in this particular.

Relative Cost of Different Depths—There is not very much known about the relative advantages of filters of shallow or deep construction. The choice of depth is usually made for entirely different reasons from those of obtaining the most economical construction to obtain the desired amount of purification. Very few tests of a comparative kind have been made to give convincing information, and the interpretation of the tests has not been uniform. In some places the conclusion has been made to make filters say 10 feet, at other places 6 feet, and some study is worth while to determine what if any difference there be in the cost of such construction at different depths, and which would appear to be the better. It is to be assumed in such comparisons that sufficient head

would be available in any case for the greatest depth to be considered and that pumping would not be necessitated by building filters of the greater depth.

For intermittent sand filters questions of depth do not arise. The filters are generally made as shallow as is consistent with getting proper results and sand beds are not usually made more than 4 or 5 feet deep as a maximum. Shallower beds, even, will give about the same output as the deeper beds, and beds are made deep only so that sand may be removed for cleaning without removing the sand for a considerable period.

With contact filters it is recognized that from the nature of the action of the contact filters, where the amount of air that is drawn in between fillings of sewage is practically equal to the volume of the sewage, and where surface clogging cannot be a serious factor and may even be no factor at all, each unit of volume of the stone forming the filter, say each cubic yard, will give the same output of sewage purification, no matter what may be the depth of the filter.

From this it follows that it is economical to build a sewage filter on the contact principle as deep as local conditions of construction will permit, and the limitation of depth which it is economical to use is therefore made by the factors of earth excavation or fill and the possible head available without pumping.

When it comes to sprinkling filters, the problem becomes a little more complicated. The English experience, as recited in the Report to the Royal Commission, seems to indicate that the output per unit of volume of sprinkling filters is the same, no matter what the depth. Our experience in work in this country does not wholly corroborate this information. Our best knowledge seems to indicate that the output per unit of volume of sprinkling filters is somewhat less for deep filters than for shallow filters. For such conditions, with a relatively decreasing efficiency of the stone of the filter beds for greater depths and at the same time a relatively decreasing cost per unit volume of the stone for deep beds, there must come some

point where the greatest output per unit of cost will be obtained.

The Report of the Baltimore Sewerage Commission in 1911 gives some information obtained from tests made in Baltimore as to the relative efficiency of various depths of broken stone of sizes 1 to 2-inch stone, which is the one most commonly used. Figures obtained from that source show the following:

	6 ft.	9 ft.	12 ft.
Relative stability	79	87	89
Per cent. reduction of oxygen consumed	56	70	72

Giving equal weight to the relative stability and per cent. reduction of oxygen consumed, we get the following:

	6 ft.	9 ft.	12 ft.
Relative stability	1	1.2	1.23
Per cent. reduction of oxygen consumed	1	1.25	1.28
Average of the two	1	1.22	1.25
Relative depths	1	1.33	2.00
Relative value of stone per cubic yard	1	.92	.63

Assuming this depth varies at a uniform rate from one end of the curve to the other, we get the following for the relative value of stone per cubic yard:

Depth of bed	6 ft.	7 ft.	8 ft.	9 ft.	10 ft.	12 ft.
Relative value of stone per cubic yard	1.0	0.97	0.94	0.92	0.82	0.63

To get comparative figures then between the 6, 8, and 10-foot beds the cost figures for the 8-foot beds must be divided by 0.94, and the cost for the 10-foot beds by 0.82, putting them all on the basis of the 6-foot beds.

For comparative cost a number of factors such as excavation, etc., are naturally omitted, as they are not affected in all places the same way by the depth of the filter. Comparing, then, only those particular costs which are affected per unit of output by the depth of the filter, we get the following:

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SEWAGE TREATMENT EXPERIMENTAL PLANT IN BROOKLYN, N. Y.

By GEORGE T. HAMMOND, *Engineer in Charge for the Department of Sewers, Boro of Brooklyn, New York City.*

The design of an experimental plant for the study of sewage disposal offers many complex problems and presents an interesting study in itself to the municipal engineer. The conditions that affect sewage disposal are so many and so various, and the methods of treatment which may be applied differ so greatly, in cost as well as in the results secured by their employment, that it has become quite usual to make experimental study in each case before deciding upon the method to be selected and the design of extensive plants. The engineer in this field owes much to the many investigations which have been made by the use of such plants during the last few years. One of the conclusions that each of these plants enforces is that each was of special value for the local object, and that the solution of the local problem could best be solved by local experimentation.

In a recent editorial referring to sewage disposal testing stations the editor of the *Municipal Journal* remarks:

"The description of experimental plants we consider of more general value than the results of the tests; for the latter are of direct service chiefly to the city whose sewage was used in the tests, while the testing plant itself, like a laboratory experiment, could be well copied by others in its most satisfactory features."

This we think is a correct and timely statement which experience justifies.

The object of this paper is to present a brief description of an experimental plant for sewage disposal investigations re-

cently designed and installed by the Bureau of Sewers, Brooklyn, N. Y. This plant was designed and constructed in response to a resolution of the Board of Estimate and Apportionment, of the City of New York, which authorized, for the purpose of constructing the plant and carrying on the experiments, the sum of $50,000.

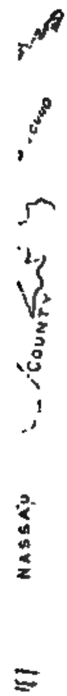
The sewage disposal problems of the City of New York are too vast and complex to permit adequate description in a paper of this length. Volumes have been devoted to the subject, and much excellent work has been done in the study of river and harbor conditions, and theoretical opinions have been obtained from the most eminent sanitarians on almost every feature and phase of the subject until it may perhaps be said with confidence that little more remains to be learned regarding river and harbor conditions, unless these should change as a result of city development, which is slowly, perhaps, but surely modifying shore lines and tidal effects.

The data obtained by the Metropolitan Sewerage Commission, which are at present available, conclusively prove the urgent need of adequate sewage disposal; but no experimental work for the purpose of determining the most available methods of sewage treatment has hitherto been undertaken.

The necessities for sewage disposal of a rapidly growing population demand immediate and practical solution with such expenditure as the taxpayer, already heavily burdened, can afford.

The sewage treatment and disposal which experiment shall demonstrate will be the most reliable, economical and simple, and which will, without offense or nuisance, for the least cost of construction and maintenance, insure an effluent, satisfactory and suitable at all times for discharge into our local bodies of water or waterways, we consider the most available for the purpose.

Naturally the scope of the experimental work for which this plant is designed includes investigation connected with sewage disposal generally, as well as the special and practical experi-



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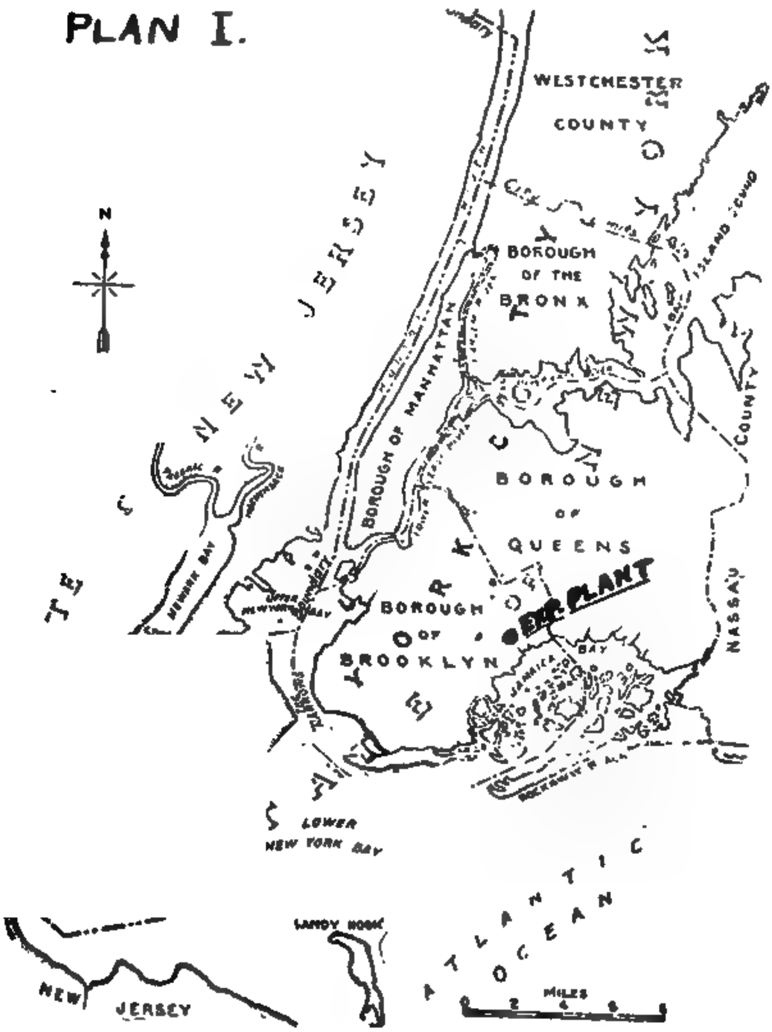


Location of the Brooklyn experimental sewage treatment plant.

ments which are more directly related to the special object of selecting the most suitable method of treating the local sewage. The general study includes rainfall and storm-water run-off; subjects so closely related to sewage treatment and disposal that their investigation could not properly be omitted,

especially as the larger portion of the existing sewerage is now, and probably will continue to be, on the "combined" plan. Of course the investigations include a complete analytical study of the sewage and storm-water flow, and such biological study as may be necessary for the end in view. The chemical and bacteriological work has been carefully provided for, a completely equipped laboratory being an essential feature of the plant.

It is intended, in the experimental work, not only to follow the general scheme of investigation for which immediate provision was made in the structures now erected, but also to change the structures, from time to time, as may seem desirable to follow other lines of investigation suggested as the work progresses.

The various methods of sewage treatment for which initial arrangement was made in the design are those which the experience of sanitarians indicates as applicable to existing conditions. Before designing the plant the state of the art was studied as carefully as possible, both in this country and in Europe.

It is not intended in this paper to present results which at this time could only be derived from a short period of experimental operation; our object is to describe the plant and the general purpose of the work; and call attention to the employment of such means for solving sewage problems, hoping that the field covered may prove of interest and possibly afford an interesting subject for discussion.

The experimental plant is located in close relation to the existing New Lots, or 26th Ward, Sewage Disposal Plant, and obtains its sewage from the main sewer, which serves the 26th Ward district of Brooklyn. The sewerage system, for which this sewer is the outfall main, serves a population of about 200,000, occupying an area of approximately 5,000 acres. The sewers are on the combined plan and have rather flat grades. The disposal plant is about two miles from the center of population and the sewage becomes septic, during the warm

months of the summer, before reaching the outlet. A new disposal plant is urgently needed for this district, and has been authorized, the design to await the results of experimental study to determine the most suitable method of treatment for local conditions.

The daily flow in dry weather, determined by weir measurements in the outfall, varies from 18,000,000 to 22,000,000 gallons. The storm-flow ranges up to about 1,000 cubic feet per second, tho the ordinary storm does not give more than 300 to 500 cubic feet per second. The dry flow is mainly of a domestic character, but there are some trade wastes that may require special study. The suspended matters vary widely in quantity at different seasons and different hours of the day. The rapid increase of population occupying the drainage area is notable and of interest in showing how rapidly New York suburban districts become urban, as may be seen from the following table:

Increase of Population, 26th Ward, Brooklyn.

Year.	Population to the Nearest 1,000
1880	13,000
1890	30,000
1900	66,000
1905	94,000
1910	178,000
1914	200,000 plus

The sewerage system was mainly installed between the years 1890 and 1896 and includes a chemical precipitation sewage disposal plant, designed in 1888 and intended to take care of a maximum population of 35,000, which, at the time, was considered ample provision for the future. This plant was completed in 1896, when the population had already reached about 60,000, and was inadequate from the beginning of its operation, altho for several years, it rendered fairly good service. It cost $350,000 and is, at the present time, nearly useless. The grade of "purification" secured was never satisfactory for an effluent to be discharged into a body of

water of the character of Jamaica Bay, in which the shell fish industry is extensive and of great value. All the sewage passing thru the plant flows thru fixed screens, thru long, narrow settling tanks, with considerably velocity, to a central well, from which it is pumped into the outfall sewer; the pump capacity is about 16,000,000 gallons per day. The storm-water flows directly into the bay without treatment or screening.

The area of Jamaica Bay and its tidal tributaries is 19.28 square miles, at mean tide level, and the tide range is about 4 feet. It is a tidal reservoir connected with the ocean by Rockaway Inlet, which affords a rather narrow and deep channel. The greater portion of the bay has a depth, at low water, of 2 to 5 feet, with extensive flats along the northerly portion, which have become considerably polluted with sewage sludge near the outlets of the sewers. The bay contains numerous small islets and mud flats, bare at low tide, and extensive bars used in the cultivation of shell fish. The sewer outlets are remote from the shell fish beds at present worked.

The main sewer above referred to is a combined sewer with flat grades; it is a twin sewer of section area equivalent to a circle 15 feet in diameter.

The experimental plant consists of three Imhoff tanks, each of different depth but with other dimensions equal; six sprinkling filters, two of which receive forced aeration within the mass of the medium; various tanks and apparatus for the investigation of sewage treatment by forced aeration; secondary settling tanks for the sprinkling filters and the sewage treated by forced aeration; a plain settling tank for crude sewage in connection with an airtight sludge digestion tank, which receives the settled matters and sludge from the plain tank, being in effect the two essential portions of an Imhoff tank separated; a roughing filter; ten sludge drying beds; various experiments for screening sewage, and for drying sludge, including a fixed mesh screen, a rotary disc type screen, and a canvas vacuum filtration system; various provisions for disinfection experiments, etc.

The mechanical plant consists of steam-actuated sewage pumps and an air compressor.

The twin sewers pass, at the location of the existing disposal plant, thru a silt basin which, in dry weather, acts as a grit chamber for the sanitary sewage. This basin, which is covered with a masonry roof carried on I-beams and piers, is 80 feet by 60 feet in interior dimensions, and 9 feet deep. The line of the sewer is continued thru it by the outfall sewer, the invert of which is 2 feet higher than the inverts of the twin sewers. The outfall sewer is a single section, 26 feet wide, of the same discharge capacity as the twin sewers, and for the first 300 feet is of masonry with a flat roof supported by I-beams, after which it becomes an open timber structure which crosses the salt marshes, about 4,000 feet, to Jamaica Bay.

A passage, 48 inches in diameter, is provided with its invert at the floor elevation of the silt chamber, for carrying the dry weather flow into the existing sewage disposal plant, where, after having received its charge of milk of lime, and having passed thru the screens and tanks, it flows into the central pump well, from which it is pumped, against an average head of 20 feet, into the outfall sewer, about 100 feet, downstream from the silt basin. A low dam, 9 inches high, is provided in the outfall sewer to prevent the sewage, pumped from the well, from backing up into the silt basin. During storms the sewage by-pass valves are closed and the entire flow of the combined sewer discharges directly from the silt chamber, over the dam referred to, thru the outfall sewer to the bay.

The pumps that furnish the sewage for the experiments are located within the existing disposal plant building, and steam is obtained from the boilers of the plant. There are two sewage pumps, both of them direct acting piston pumps, installed so that either pump may be cut out and cleaned or repaired without stopping the other; either pump may be operated alone; or both may be operated at the same time. The larger pump has a capacity of 1,200,000 gallons per day, and the

Fig. 3. Experimental plant from the north.

Fig. 4 Experimental plant from the west.

smaller 650,000 gallons. Provision is made for placing a movable screen around the lower end of the common 12-inch suction pipe thru which both pumps operate. This screen consists of a steel frame, upon which wire meshes of varying fineness can be used. The screen is cleaned by means of a water jet and brush.

The sewage for experiments is taken from the sewage passage between the silt basin and the disposal plant, and is practically free from grit. It is discharged from the pumps thru an 8-inch iron pipe into the quieting tank, which supplies sewage to the various units of the experimental plant by gravity.

As the experiments include an extensive study of sewage aeration by means of compressed air, a sufficient supply of air is of great importance. The compressor installed is a duplex crank and fly wheel machine; automatic in starting, stopping and speed; with a displacement capacity of 228 cubic feet of air per minute at not exceeding 210 r. p. m. for 30 lbs. air pressure, with 100 lbs. of steam at the throttle. It is equipped with a combination speed and pressure governor, arranged to bring the machine to a dead stop if no air is demanded, and to start up automatically when the pressure drops. It has enclosed splash lubricated frames and bearings, making lubrication automatic. The air cylinders are provided with water jackets. The air passes from the compressor to an air receiver, of steel, 24 inches in diameter and 72 inches high, with pressure gage and safety valve.

The low elevation of the ground at the site—but a few inches above ordinary high tide, a tidal marsh in fact—necessitated the design of an experimental plant above the reach of the highest tide, and pumping of the sewage up to the required level from which a gravity flow could be obtained for every unit of the plant. This was not only the most available design, but afforded some advantages, such as the possibility of getting at the structures from the sides, in most plants inaccessible on account of being placed underground.

The datum line was at mean high water and the surface of the sludge beds made at an elevation of 2.67; all of the other units of the plant were given such elevations above this as their operation required. Every unit was provided with a measuring device for the determination of the quantity of flow, usually consisting of an adjustable calibrated orifice above which a constant head is maintained by a system of overflow weirs.

For measuring compressed air, venturi meters were provided.

The accuracy of all the measuring devices was carefully tested in place.

The first thing determined, in making the design, was the required elevation of the surface of the sewage in each unit of the plant. This determined, the unit was designed to comply with it; and to support the structures in the situation selected, pile or other foundations were provided, as required. The design of such structures as the sprinkling filters, carried on piles, which in the permanent plant might be of concrete, with the peculiar form of "slab-between-piers" for outside walls, to secure the lightest construction with the largest possible aeration surface from the sides, was considered a study no less interesting than the treatment of sewage in the filters themselves. The above-ground construction of the plant affords opportunity for studying the flow of sludges of different kinds, Imhoff especially, which could not as easily have been observed otherwise. The effect of cold weather on exposed sprinkling filter beds; and the danger of freezing of the various channels carrying sewage, and the proper method of protecting and operating the same; are incidental studies of great importance in view of the projected construction of a plant on piles over an extensive marshland.

Early in the studies which preceded the design of the experimental plant it was of importance to ascertain the quantity of sewage flow per day and per capita from the drainage and sewer district, the entire flow passing into Jamaica Bay at this

Fig 5 Experimental plant from the south.

1. Quieting tank into which pumps discharge and from which sewage flows with determined constant head to treatment tanks.
2, 3, 4. Imhoff tanks Nos. 1, 2 and 3, partly hidden by other structures.
5. Roughing filter at end of dosing tanks.
6. Dosing tanks.
7. Sprinkling filter bed before construction of wind shield around tops of beds.
8. Aerating tank.
9. Aerating siphon.
10. Sprinkling filters with forced aeration. At their base settling tanks and sludge drying beds.
11. Secondary settling tanks below the sprinkling filters (7).

point thru the main sewer, as already described. This was done by means of a knife-edge weir with end contractions suppressed, installed in the open outfall trunk sewer. This weir, which was of notable length on the knife-edge (26.83 feet), was described in Engineering News. The experimental nature of the work indicated that all of the structures provided for the plant should be so designed and built that changes and variations might be made, without great cost or difficulty, to carry out more fully such variations in the investigations as may seem of interest or may be suggested by the tests as they proceed.

Quieting Tank.

The quieting tank stills the flow coming from the pump, and supplies a regulated supply of sewage to every part of the plant, maintaining a constant head in the supply at an elevation of 33.42. It is placed on top of a strongly braced platform. This entire structure is built of timber. The supporting posts are 6 inches by 6 inches yellow pine, and the tank walls are of yellow pine 2½ inches thick. A platform around the tank is provided for convenient inspection and operation, which is connected by means of a bridge with the tops or "decks" of the three Imhoff tanks. A handrail is also provided around the platform for safety. This tank is rectangular in shape, 5 feet in depth, and 12 feet 3 inches by 8 feet 10 inches in plan. In its interior each end is divided off by a partition, forming overflow chambers, which are connected with the waste pipe; the main chamber is between these internal partitions and is 9 feet in length by 8 feet in width. Each partition is cut down to the waterline a distance of 3 feet from the outlet side of the tank, forming overflow weirs designed to maintain a constant head over the outlet orifices. Two baffles are placed lengthwise of the tank, between the above mentioned partitions and normal to the line of flow. The baffle nearest to the entrance of the sewage extends 3 feet upward from the bottom, and is 2 feet 6 inches from the entrance side of the tank. The other baffle extends downward, from the

top of the tank, to within 1 foot of the bottom, and is 2 feet 6 inches from the first baffle, parallel with it, toward the outlet side. Thus, the sewage which enters, submerged, rises over the first baffle and then passes downward under the second, before entering the constant level chamber from which it is fed, through the adjustable orifices, to the various units.

In the side of the main chamber of the tank, opposite to the entrance of the sewage, are placed six outlets, each provided with an adjustable orifice having a calibrated scale, which may be set to any rate of discharge within its range of capacity. These orifices discharge into flumes that lead to the various experimental units, each orifice into a flume which it serves. The method of measurement employed depends upon the use of a graduated adjustable orifice, discharging under a constant head, calibrated in place by actual measurement of the discharge in one of the large tanks emptied for that purpose. The means of maintaining a constant head is, in all cases, an overflow weir, over which a surplus flow is kept wasting to a lower level, where it may be used, if required, for other experiments or led back to the main sewer. As the supply pumps are steam-operated piston pumps, capable of adjustment to the requirements of the experiments, no great amount is wasted, and no difficulty is experienced in keeping the head constant. This method of measurement was adopted as part of the design of the plant after extensive investigation of possible methods of measuring sewage under the circumstances of these tests. The orifice boxes with their overflow weirs were built by the contractor for the experimental plant; but a separate contract was made for supplying and installing the orifice fixtures themselves, and the Venturi meters for measuring compressed air, including their calibration in place, with the Wallace & Tiernan Co., Inc., of New York. The smallest orifice called for was required to measure flows ranging up to 150,000 gallons, the largest up to 600,000 gallons, in 24 hours. The adjustable orifices are made of bronze, all sliding parts are machined so as to work easily and yet fit tightly. They are

Fig. 6. Decks of Imhoff tanks.

Fig. 7. Top of Imhoff tanks. Part of deck removed, showing a week's scum formation without disturbance. Photo taken August, 1914, at air temperature about 80° F

NOTE—For the most part the surface is entirely clear. There are a few places where a slight skin has formed on which algae have grown. There has not at any time been any smell of sulphuretted hydrogen.

made according to the principle of hydraulic discharge; but the discharge, as actually measured, varied somewhat owing probably to the velocity of approach thru the 2-inch planking of the wall of the constant level boxes, on the outside of which they were placed.

Three of the flumes leaving the quieting tank pass to the Imhoff tanks, each tank having its individual flume by which it receives sewage from the quieting tank. These flumes are supported on a bridge or platform carried on angle iron supports projecting from the sides of the Imhoff tanks.

Imhoff Tanks.

The Imhoff tanks, three in number, differ only in depth, each being provided with a sedimentation chamber with the depth proportionate to the depth of the tank in which it is placed, so that the effect of depth (other conditions being equal) may be observed in the comparative performance of the tanks.

The scum boards, placed 12 inches from and opposite the entrances and exits of the tanks, are in all cases 2 feet in depth, and no other baffling is provided for in the first series of experiments; the aim being to subject an equal flow, disregarding theoretical retention period, in each tank in parallel operation, to the same baffling. The dimensions of the horizontal section of each sedimentation chamber, at the lower edge of the scum boards, are equal in every particular in all the tanks; and the entrance and exit weirs are of identical design and dimensions. When the experiments upon the comparative effect of depth in sedimentation chamber, and sludge digestion chamber, have been completed, baffling will be provided in connection with experiments upon rates of sedimentation at various rates of flow. If found desirable the sedimentation chamber of either of the tanks, or, indeed, of all, can be temporarily removed and a rearrangement made for Dortmund tank experiments. Connection can be made between the tanks so that the whole three can be operated in series,

either as Imhoff or as Dortmund tanks, by a few inexpensive changes. The tanks are of pine staves 3 inches thick, with round iron hoops. Each tank is 15 feet in internal diameter, and rests upon a yellow pine platform, supported by caps carried on piles. The inlet and outlet of each tank is made of galvanized iron, forming a distributing or a collecting chamber, as the case may be, in front of the entrance weir, or outside of the exit weir, which weirs are both full width of the sedimentation chamber; the aim being to distribute the flow uniformly, and to take off the effluent in the same manner.

The material of construction of the sedimentation chambers is pine, so put in as to be easily removed and reconstructed, as may be desired in the course of the experiments. The sloping floors, which are of 2-inch pine, planed smooth, were placed first, after which the vertical sides were put in place, which are of 1¼-inch pine, planed smooth, their lower ends resting upon the sloping bottom planks, so as to eliminate a vertical joint. These vertical walls are 10 feet 8 inches between sides and a maximum of 2 feet between these and the outer shell. The sides and sloping floor are of tongued and grooved boards, carefully matched and smoothed inside. The spaces between the vertical walls and outer shell serve as gas outlets for the digestion chamber.

In making the openings from the sedimentation chamber for the passage of settlings into the digestion chamber, the inclined floors do not lap or pass, the one below the other, as is frequently the case in such tanks, the intention being to study the form of opening by changing it, perhaps several times; the form at present installed having been considered the most troublesome to try out was selected for the first trial. There is some reason to think that this form of opening is less liable to become clogged than the form ordinarily used, and in six months' service it has worked so well that no collection of settlings has at any time remained upon the slopes. The opening is guarded by means of a timber shield or baffle board placed below it with its upper slopes the same as the bottom slopes

of the sedimentation chambers, thru which the sludge pipe passes at the center of the tank, care having been taken to make the pipe passages gas tight thru the wood. The sludge pipe in each tank is 8-inch iron pipe with a flange at the top, provided with a cover, and is carried by two 6-inch by 8-inch yellow pine timbers crossing the top of the tank; the

Fig. 8. Aerating tank and aerating siphon.

pipe is suspended from iron channels crossing from timber to timber and placed under the flange at the top. The sludge pipe is provided with a branch pipe for drawing sludge, which passes thru the side wall of the tank, having a gate valve and being connected with the sludge outfall channel into which it discharges.

The bottom of each digestion chamber is formed inside of the cylindrical tank, in the shape of an inverted truncated hexagonal pyramid, made in two sections, the upper overlapping the lower. A perforated lead pipe, 1¼ inches in diameter, connected with the city water supply, and controlled by a gate valve, is placed entirely around the tank, under the overhanging edge of the upper pyramid, for use to start the sludge sliding down the slopes, if necessary, and for cleaning the slopes.

The effluent from the tanks may be distributed by gravity from the outlets to all the experimental units where its use is required. As there will, at all times, be a considerable surplus of effluent, provision is made to return this to the main sewer by means of a waste pipe controlled by a gate valve leading from the outlet trunk of each tank. As these waste pipes, which are all of iron, 4 inches in diameter, are led down the sides of the tank they afford branch connections, provided with gate valves, for tapping the tank at lower points. Thus it is possible to entirely discharge the contents of the sedimentation chamber without disturbing the sludge digestion chamber. It is also possible either to obtain samples of sludge from the bottom of the tank without the disturbance that would be caused by drawing thru the 8-inch sludge pipe, or to discharge the entire contents of the whole tank when repairs or alterations are required, thru this lower outlet.

The tanks are covered on top, except for the opening over the inlet and outlet weirs, with movable floors, made of 2-inch pine plank, in sections, with lifting rings for handling. The floor affords an acceptable deck, which is reached by means of a stairway from the main floor; it is surrounded with a

handrail, and bridges are provided between the tanks which afford easy access for taking samples or conducting the tests, as well as for the convenience of visitors.

As already stated, all of the Imhoff tanks are wooden cylinders 15 feet in internal diameter, and they differ only in vertical dimensions and cubic capacity. The bottoms of all the tanks are exactly alike in all dimensions, as are the tops, the inlet and outlet weirs, and the scum boards. It will be necessary, therefore, only to mention the dimensions in which the tanks differ, the depths being given inside from the waterline downward.

	Depth of Tank at Center	Depth of Sedimentation Chamber Vertical Side	Center
Tank No. 1.............	30.38 feet	9.22	13.97
Tank No. 2.	21.88 feet	5.30	10.05
Tank No. 3.............	13.67 feet	2.42	7.00

As these tanks are constructed of timber, changes in the interior arrangements for experimental purposes, such as increasing or diminishing the degree of the sloping bottoms, both of sedimentation and of sludge digestion chambers, are easily possible; also changing the design and width of the opening between the upper and lower chambers. The intention is to vary these parts during the course of experiments for purposes of study. With this end in view the slopes were provided as flat as was thought safe, but so far they have not retained any sediment and probably might have been flatter without causing trouble. These tanks have operated since October 4, 1913. Probably the smooth timber surface affords less friction to the sliding of settled matter than would concrete. It is intended to cover the slopes with a concrete surface, before the completion of the experiments, to investigate this question.

The effluent from the Imhoff tanks flows by gravity to the following units, all of which may be simultaneously in action:

1. The sprinkling filters and roughing filter.
2. The aerating tank.
3. The aerating siphon.

Fig. 9. Discs for aerating tank. Nine are placed in the tank.

Fig. 10. Top of aerating tank showing surface of sewage under aeration.

4. The sprinkling filters with compressed air aeration.
5. To a secondary settling tank.
6. To disinfection tanks.
7. To mechanical vacuum filter tanks of the Moore pattern.

Sludge for testing and drying is discharged to the Imhoff drying beds; the surplus sludge is washed into the main outfall sewer.

Plain Sedimentation With Sludge Digestion.

Plain sedimentation experiments are provided for in a tank of the Dortmund type, which is one of a group of four tanks, each of the same size and design, constructed of concrete, 8 feet by 8 feet in interior plan and 8 feet deep from the waterline in the center, the bottom being designed of pyramidal form. The other three of these tanks are used as secondary settling tanks for observing the effluents of the aerating siphon, aerating tank, and the Imhoff tank. The flow, entering, is carried down under the center of the tank and, rising, is taken off thru V-shaped notches, of which two are provided on each side, into wooden troughs which completely surround the top of each tank. A 6-inch sludge discharge pipe is placed in the center, terminating with a bell at the bottom and provided with a clean-out at the top of the vertical portion above the water surface. Sludge is discharged thru a horizontal branch, passing thru the tank wall below the waterline, into a flume that carries it to the sludge beds. The tank selected for raw sewage sedimentation has, in addition, a sludge discharge pipe branching from the pipe described above, which passes to a sludge digestion tank especially provided for the purpose of experimenting with sludge taken from raw sewage.

The sludge digestion tank is of steel, made to be air and water tight. It is 5 feet in diameter and 15 feet in depth, with a pyramidal bottom, set vertically in the ground so that no part of it shall be above the waterline of the plain sedimentation tank from which it receives sludge. The effect of varying temperature or of chilling from ground-water is mini-

mized by a double shell with an air space between shells. In operating the tank, sludge is drawn from the settling tank under water pressure due to the head of water in the tank, by means of a branch in the sludge pipe, and passes thru the sludge inspection box after opening the valve into the digestion tank. The sludge remains in the digestion tank until it is digested. Before any sludge enters it is necessary to let out

Fig. 11. Compressed air pipe entering aerating tank, marked A.

enough of the water from the top of the tank to furnish sufficient difference of head for the sludge to flow in. The digested sludge is discharged upon the Imhoff drying beds by means of the sludge pipe in the same manner as from an Imhoff tank.

DIRECT AERATION OF SEWAGE WITH COMPRESSED AIR.

Direct aeration experiments may be carried out with raw sewage supplied from the quieting tank, or with the effluent of the Imhoff tanks. The principal direct aeration experiments provided for are to be carried out by means of an aerating siphon, and an aerating tank. Experiments will also be made with sprinkling filters supplied with compressed air thru a grid placed within the mass of medium.

The aerating tank is a design developed from experiments made at the Twenty-sixth Ward Sewage Works, in 1911, by Col. William M. Black and Prof. Earle B. Phelps, which gave much promise. Other experiments will be made than those mentioned.

Siphon Aeration.

The siphon aerator is an application of the siphon air compressor principle to the aeration of sewage, proposed by the late C. C. Beddoes, who obtained a patent covering the use of the siphon for sewage aeration. It may be operated with raw sewage or Imhoff effluent. The flow of sewage is led, by gravity, to the bell at the top of the siphon down-take pipe, into which the sewage falls, entraining or sucking the air in with it, and passing vertically downward thru the pipe with considerable velocity, the entrained air becoming compressed. It is claimed that the sewage exposed to air under pressure absorbs a greater portion in consequence of the pressure, as the volume of air absorbed will be in proportion to the pressure. The apparatus consists of a 4-inch pipe extending vertically, downward, 130 feet from the bell at the top; first thru the center of a vertical tank 30 feet deep and 4 feet in internal diameter, and, second, from the bottom of the tank thru an 8-inch pipe, leaving an annular space thru which the sewage can flow upward from the bottom of the 4-inch pipe into the vertical tank, in which it is retained for a period of time in proportion to the quantity of flow and capacity of the tank. The effluent is discharged from the top of the vertical tank by means of a waste pipe and a measuring orifice box from which a portion of the flow is led, for observation, to the settling tank.

Tank Aerator.

The tank aerator is for the purpose of experimenting, both upon crude sewage and Imhoff tank effluent, with forced aeration, either by fill and draw or constant control. It is a tank 12 feet in diameter and 25 feet 8 inches in height. The sewage

enters at the top of the tank by gravity at eight points from the quieting tank or the Imhoff tank outlets. The sewage may fill the tank so that these points of entrance are submerged, or the tank may be operated at lesser depths of content. The sewage or effluent of the tank is taken off at the bottom by means of four 3-inch openings into a 5-inch pipe.

A grid for supplying compressed air is placed at the bottom of the tank, upon 7½ inches of broken stone, the same depth of broken stone being placed over it. The grid consists of 1½-inch pipes at right angles, forming a cross, connected in the center, the arms of the cross being connected with quarter-circles of ¾-inch pipe forming concentric rings, of which there are five; each ring being perforated at 6-inch intervals with 1/16-inch holes. The air enters thru the 1½-inch pipes and is distributed thereby to the rings, and is discharged into the broken stone surrounding the grid, which tends to break up any upward streaming effect.

The main outlet for the tank effluent is 1 foot above this grid.

Thru the central axis of the tank is placed a vertical 4-inch pipe which serves to center and support the deflector discs, of which there are nine, provided for the purpose of deflecting the downward flow of sewage and upward flow of air bubbles, so as to obtain even distribution of both air and sewage.

The deflectors are designed in the form of a wheel with a hub which is of iron; six radial arms are provided between which slats are placed, running from arm to arm, the slats being set in grooves in the arms and at an angle of about 45 degrees with the horizon, the slats in each alternate deflector being set at angles alternating from and toward the center in order to give the sewage a sinuous motion in passing downward.

Fig. 12. Walls of sprinkling filter beds under construction.

Fig. 13. Side walls, partition and under drains of sprinkling filters.

Sprinkling Filter Beds.

There are six percolating or sprinkling filter beds, all of them supplied with sewage by means of dosing tanks, and the sewage applied may be

(1) crude from the quieting tank;
(2) aerated sewage effluent from the siphon aerator;
(3) aerated sewage effluent from the aerating tank;
(4) settled sewage from the Imhoff tanks;
(5) any of the foregoing passed thru a gravel roughing filter;
(6) effluent from fine screens of the Reinsch-Wurl pattern (not yet installed).

The sewage flows by gravity to the dosing tanks, except the fine screen effluent which requires pumping.

Each dosing tank is provided with a 5-inch Miller siphon which discharges the dose into the inverted pyramidal feeding tank from the bottom of which it is carried by a pipe embedded in the medium to the sprinkling nozzle, by which it is sprayed over the bed. These tanks, and the inverted pyramidal feeding tanks into which they discharge, are constructed of yellow pine. The gravel roughing filter is also constructed of yellow pine and is so arranged that sewage, on its way to the dosing tanks, may be passed thru it; the medium provided is gravel passing a ¾-inch ring and retained on a ½-inch ring. The gravel is 12 inches deep, supported in the middle third of a wooden tank by means of a wire screen of ¼-inch mesh. Such a filter has been found very effective by Mr. Watson at Birmingham for protecting the spraying nozzles. It is very effective as a remover of hairs and small particles that have escaped the settling tank. The roughing filter may be used or by-passed at will.

The elevation of the dosing tank water line at the instant of siphon discharge is 26.74 feet, which is 9.40 feet above the surface of the filter beds. The elevation of the water line in the inverted pyramidal feeding tanks is controlled by the

Fig. 14. View of sprinkling filter beds taken from dosing tanks.

Fig. 15. Sprinkling filter beds taken from the surface of beds, showing wind breaks.

amount of sewage discharged from the dosing tanks, and its maximum elevation with the largest dose that can be discharged is 23.50 feet, which is 6 feet 2 inches above the beds. This head can be varied by a movable bulkhead placed in the dosing tank which varies the quantity of discharge delivered by the siphon and increases the number of doses per hour.

The sprinkling filters, all of which are served by a single group of dosing tanks, are divided into two groups. The first consists of four filter beds of the ordinary type; the second of a tank 12 feet in diameter and 16 feet high, in which are placed two beds. A partition wall divides the tank into two equal parts and each side is filled with stone filtering medium to the same depth. The bottom of each side is underdrained with 6-inch half-pipe tile on a concrete bed, and is closed from external air by the tank walls. Each side is kept entirely separate from the other and drains independently to a secondary tank. Each side is provided with a grid, for supplying compressed air, placed within the medium near the bottom of the beds, formed of ¾-inch iron pipe perforated every 6 inches with ⅛-inch holes, thru which the compressed air is supplied.

In operation, the sewage is sprayed upon the surface of the beds by a single nozzle placed at the center of the two beds, over the dividing wall between them. Both beds may be operated as ordinary sprinkling or percolating filter beds, in which case air is carried into the bed from the surface only. Compressed air may be supplied to both sides at the same time, or one side may be operating as an ordinary sprinkling filter while the other is operated as a sprinkling filter with compressed air added in the bed, in order that the effluents may be compared and the effect of the added air be observed.

The filtering medium in both sides is best selected trap, broken to pass a ring 2½ inches and be retained by a ring 1¼ inches in diameter. The depth of the medium is 10 feet, which may be increased to 14 feet by adding to the surface and raising the nozzle.

Fig. 16. Side of sprinkling filters taken from top of secondary settling tanks.

Fig. 17. Sprinkling filter beds and dosing tanks in midwinter. Temperature 50° F. Wind breaks not yet placed around beds at surface. Operation not interfered with.

The ordinary type of sprinkling filters consist of four beds, built in one group; the foundations are carried on piles and caps; the bottoms of the beds are 6 feet above the level of the marshland over which they are built. High water at times washes underneath, covering the marsh to a depth of 6 or 8 inches. Each bed is square and has an effective area of .005 of an acre.

A partition, 4 inches thick, is carried from the floor to the surface of the medium between each adjacent bed.

The floor is formed of concrete with a slight slope to the outlet of the underdrains. Half-tile, 6 inches in diameter, are laid with the convex sides up, on the concrete floor, to afford drainage, the effluent flowing to gutters or troughs placed around the bottom of the beds, outside of the wall piers; each bed having its individual gutter, discharging by means of iron pipe to its individual secondary settling tank.

The outer walls of the beds are formed by means of reinforced concrete piers carrying a slab coping of reinforced concrete at the top. Piers are cast with slots for receiving 3-inch yellow pine slabs or shutters, which are set at an angle of 45 degrees, sloping inward, spaced 2 feet apart, against which the medium rests, affording a maximum admission of air and preventing the escape of sewage.

The medium is 10 feet in depth over the top of the underdrains and is of very carefully selected broken trap rock, many runs thru the screens having been necessary to obtain the result required.

Fig. 18. Samples showing effect of aeration on sewage. Relative stability in the samples approximately agrees with the relative clarification in them. Background is a sheet of white bristol board to which is attached a ½-inch strip of black tape. The ease with which this tape is seen through the samples is a measure of their clearness.

Fig. 19. Samples showing effect of treatment. Sample No. 1 is crude sewage; No. 2 is effluent from Imhoff tanks; No. 3 is effluent from sprinkling filters; No. 4 is effluent from secondary settling tank or may be tap water for comparison. Bristol board and black tape are used as in Fig. 18. Bottles are numbered from right to left.

Size of Medium in Filter Beds.

Bed No. 1, stone passing ring 1 1-2 inches in diameter, retained by 3-4-inch ring.
Bed No. 2, stone passing ring 2 inches in diameter, retained by 1-inch ring.
Bed No. 3, stone passing ring 2 1-2 inches in diameter, retained by 1 1-4-inch ring.
Bed No. 5, stone passing ring 2 1-2 inches in diameter, retained by 1 1-4-inch ring.
Bed No. 6, stone passing ring 2 1-2 inches in diameter, retained by 1 1-4-inch ring.
Bed No. 4, stone passing ring 2 1-2 inches in diameter, retained by 1 3-4-inch ring.

In order that the effect of the depth of filter medium under similar conditions of operation may be obtained, test trays with outlet pipes are placed in the filter beds at different depths. The trays are V-shaped, 10 inches wide, and extend from the wall to the center of each bed. Each is provided with a drain pipe with a stopper, used when samples are being obtained. The trays are so placed that samples may be taken at depths from the surface of the bed of 6 feet, 7 feet 3 inches, and 8 feet 6 inches. Samples taken from the bottom of the bed give the result of 10 feet depth. Thus, samples from four different depths of medium are available for observation from each bed.

In order to prevent the effects of wind on the sewage distribution, a shield is provided, consisting of a board fence at the surface carried between the beds and around them.

The secondary settling tanks to which these filters discharge are placed in a group. Each tank is an inverted truncated pyramid, 10 feet deep from the water line. The flow enters thru a 2-inch pipe down to a point 2 feet above the bottom. Settlings are removed by means of a 6-inch sludge pipe operated by the hydraulic head of the tank. The tank effluent is taken off by troughs passing entirely around the top of each tank through V-shaped notches.

Sludge Drying Beds.

For the purpose of testing the character of sludges from the different experimental units, and making observations on rates of drying, sludge drying beds of the Imhoff type are provided. There are 10 beds, each 5 feet wide by 12 feet long.

Fig. 20. Settling tanks and sludge drying beds.

Fig. 21. Taking sample of freshly-drawn Imhoff sludge

The elevation of the surface of each bed is 2.67 feet above datum. These beds are constructed upon a timber platform carried on caps supported on piles. Each bed is supplied with a 6-inch half-tile pipe underdrain, placed along the center from near the inlet to the lower end of the bed. The medium consists of 8 inches of steam ashes surfaced with 1 inch of coarse sand. Timber partitions separate the beds, each bed being in effect a tank into which the sludge is discharged by means of sluices controlled by gates. Sludges can reach these beds by gravity from all of the sludge producing units of the plant. For the experiments only a portion of the sludge formed in the various units will be applied, the surplus being discharged into the main sewer outlet.

Disinfection Experiments.

Disinfection investigations will be undertaken when the various units of the plant have been given sufficient time to develop the best possible effluents, and the Reinsch-Wurl screens and vacuum filters are in operation. Tanks are provided for the purpose.

The experimental plant was, for the most part, completed in December of last year and put into regular service January 1st of this year. Sufficient time has not yet elapsed to make any results available for publication. The service of the sprinkling filters, during the zero weather of last winter, was accompanied with the formation of considerable ice.

The portions of the plant not yet completed include the major portion of the screening apparatus, of which two Reinsch-Wurl screens are intended to constitute an important part. A description of the screens designed and now awaiting letting of the contract for installation is, therefore, added as showing this important portion of the plant. It is intended that the screens shall remain a permanent part of the proposed sewage disposal plant to be installed at this location. Each screen will have a capacity of 6,000,000 gallons of screened sewage per day, giving a total of 12,000,000 gallons.

Fig. 22. Removing dry Imhoff sludge after three days in sludge bed.

Fig. 23. Undisturbed surface of sludge on Imhoff drying beds. The scale shows the amount of reduction in photographing and gives method of measuring drying cracks.

This location will require a much greater ultimate capacity, and additional screens of the same type may be installed at the plant as required in the future. The design of the plant provides for a by-pass between the screens so that they may be operated individually or in series so that double screening may be tried out, the second screen in the series being very fine.

The screens will be 14 feet in diameter and operated by steam engine drive, a 15-h.p. engine being provided for the initial installation. The estimated power required, as a maximum, to drive each screen and the screen cleaning devices is 4 h.p., leaving 7 h.p. available for driving a belt conveyor, etc., for removing the screenings from the building to the carts.

The apertures in the screens, or openings thru which the sewage passes in being screened, are to be made of such size as may be found to give the best results with the average flow of sewage at this location. Screening practice and experience elsewhere show that this should be determined experimentally, and with this end in view the specifications provide, in relation to this subject, that four complete sets of screen surface plates shall be supplied; each set being a complete surface outfit for a screen; each set to be cut with apertures of different dimensions, as follows—the first set to be cut with apertures 5/64-inch wide; the second with apertures 1/16-inch wide; the third with apertures 3/64-inch wide: and the fourth with apertures 1/64-inch wide; in each set the apertures will be 2 inches long and will be staggered in the bronze surface plate, which is ⅛-inch thick, each aperture to have a counter-sunk cross-section with the narrow part of the opening on the face of the screen.

These sets of screen plates are to be mounted on the screen frame successively and tried out, and the aperture dimension decided to be the most suitable for screening the sewage at this plant will be selected; the screen plates not selected re-

Fig. 24. Sludge digestion tank before placing.

Fig. 25. Sludge digestion tank in place.

maining the property of the screen contractor who may recut them, if the apertures are too small, or use them elsewhere.

The size and number of apertures in the screen surface must be such that 6,000,000 gallons of sewage will pass thru the screen in 24 hours, the difference of head of sewage on entering and leaving sides of screen plate being not more than 12 inches. The screen must remove from the sewage practically all particles of suspended matter with a diameter 50 per cent greater than the cross section of the aperture; the removal of suspended matter is intended to be approximately equal to that effected in a plain sedimentation tank with a retention of one hour, but what shall be considered a satisfactory removal of suspended matter will be determined by tests to be made with the plates having graded apertures under the Engineer's direction.

In designing sewage screens one has but little information to go on. Data are very meager and unsatisfactory. Claims are made that removal may be effected of from 25 per cent all the way to 80 per cent of the matters in suspension which would settle in an ordinary sedimentation tank in four hours. Sewages differ very widely in the character of suspended solids, and naturally the kind of screens which will serve best with a given sewage, and the required fineness of the screening surface, varies widely. In Dresden, Germany, where there are four large screens of the Reinsch-Wurl design, the breadth of the apertures is 2 m. m., which is found at that place to give satisfactory removal of suspended matter, and this is the only treatment found necessary for the sewage of that city, which, after screening, is discharged thru multiple outlets directly into the Elbe River, affording at all times a satisfactory disposal of sewage. Dresden has a population of between 300,000 and 400,000, and at its lowest stages the river is a small stream.

Slits or apertures of lesser width than 2 m. m. are said, in German practice, to reduce the capacity of the screens without much added advantage. This is especially the case where, from the nature of the suspended matter, a mat tends to form

Fig. 26. Vacuum filter, Moore system. By this method the sewage is (1) agitated with a coagulant by means of compressed air; (2) permitted to settle in a tank of the Dortmund type, the settlings being returned to the agitation tank until that becomes charged, when they are removed by being passed out at the bottom of the tank to a drying filter designed for the purpose, after which the organic matter is removed by burning and the mineral matter is recovered and used over again; (3) the effluent from the settling tank goes to tank marked "4," in which is suspended a series of canvas covered frames, each being formed like a bag of canvas drawn over a frame, the interior of the canvas bags being connected with a vacuum pump drawing the sewage through at a high rate and discharging it outside. Disinfectants are applied as required.

Fig. 27. Riensch-Wurl screen, showing frame. This and the following pictures were taken in Dresden, Germany.

over the screen surface and produce a straining effect. In Dresden the difference of head thru the screens varies from 2 to 6 c. m., under ordinary conditions, but at times is much greater than the larger figure—possibly four times as much.

The four screens at Dresden, each of which is 8 meters in diameter, with an ordinary submergence of 2.4 meters, together handle 18,000 second-liters.

DISCUSSION.

MR. MACALLUM: Have you made any tests of filtering media outside of stone?

MR. HAMMOND: Other than clinkers, not any. We expect to make tests of a number of different things and one test suggested to us, to show that the character of the medium has nothing to do with purification, is that we try some blocks of wood as media. It seems to make very little difference if the medium is stable.

MR. MACALLUM: The textbooks say that the media make little difference, but I have tried acid slag and the basic slag, and also mill cinder, and the results in each case were unfavorable, as the material disintegrated and broke down, with resulting clogging.

MR. HAMMOND: Mr. Corbett at Salford, England, had a like experience. The beds there were of mixed slag, and they were being replaced on account of disintegration when seen by the speaker in 1912; while at Birmingham, where they used acid slag, they have surfaced it with broken granite.

MR. MACALLUM: About pumping the sludge, you cannot use the centrifugal pump because of releasing the gases?

MR. HAMMOND: Dr. Imhoff thought it would be necessary to deliver the sludge in an open gutter, raising it with a pneumatic ejector to the little box at the head of the gutter. Two months later he told us he had discontinued that, and had run the line from the pneumatic ejector directly to the bed, without bad results. The sludge is used for filling, and seems non-putrescible. We have quite a pile that smells like garden mold, and on examining it you find it is made up of human hairs and shreds of material that is possibly organic, humus, etc., very little that bacteria could get hold of.

Fig. 28. The foul surface of a Riensch-Wurl screen approaching the brushes. Movement in direction of arrow

Fig. 29. Cleaned surface of screen having just passed the brushes.

Fig. 30. Screenings removed from Riensch-Wurl screen in one day's run.

Fig. 31. The screen house at Dresden.

THE DISCHARGE OF INFLAMMABLE WASTES INTO SEWERAGE SYSTEMS AND THE PROBLEM OF PREVENTION.

By N. S. SPRAGUE, *M. Am. Soc. C. E., Superintendent of Bureau of Construction, Pittsburgh, Pa.*

The author presents this paper with the hope of eliciting discussion upon this subject by those charged with the responsibility of the design, maintenance and operation of sewerage works, which may throw some light upon the ultimate solution of the problem of regulating the discharge of inflammable and explosive wastes into sewerage systems and preventing sewer explosions.

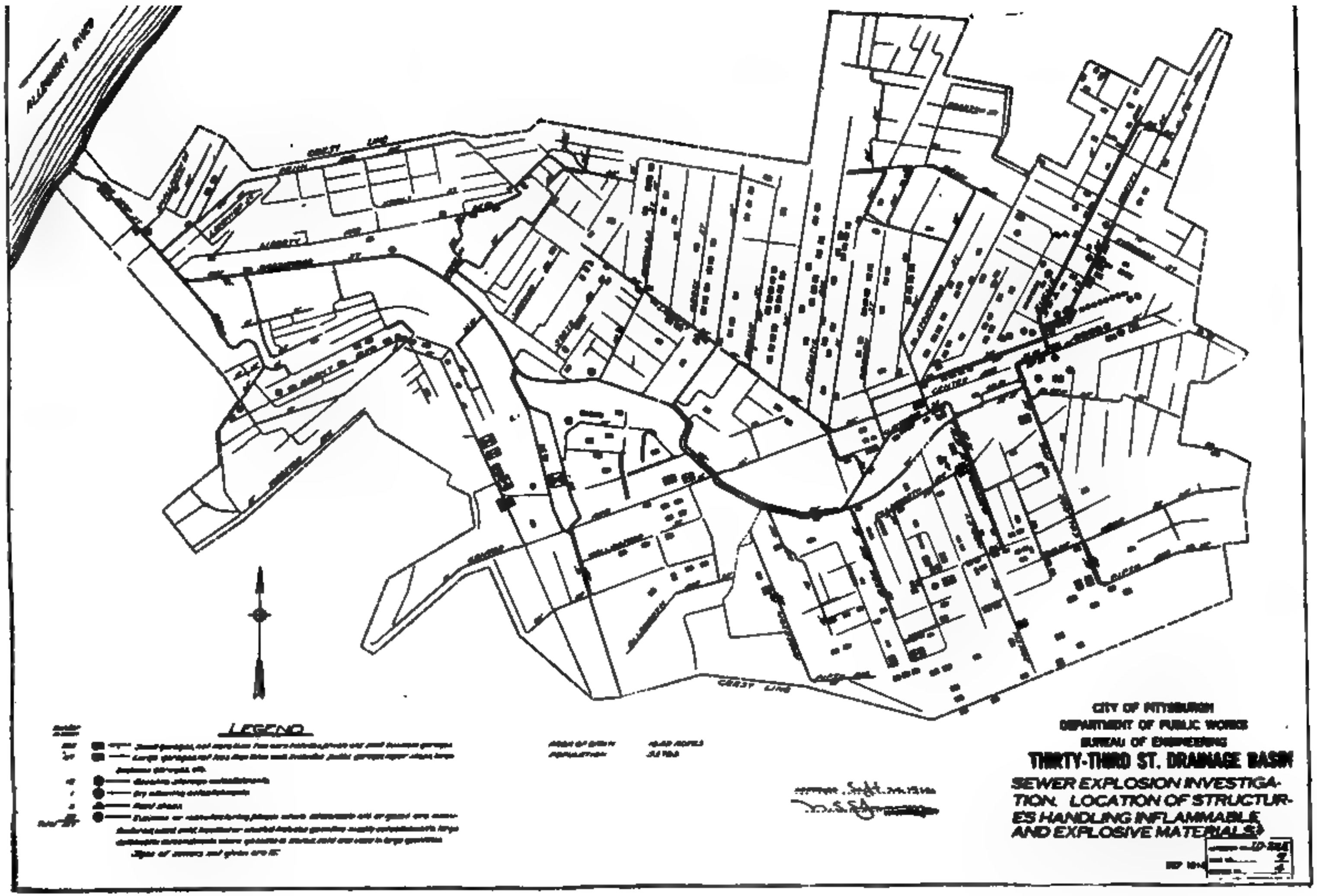
It is thought that some of the more recent and violent explosions were caused by the presence of gasoline vapor in the sewer and if this belief is accepted as a fact, then the advent of motor driven vehicles has created a problem in sewer design and maintenance which may prove difficult and expensive to solve. Sewer systems are generally looked upon by the average person as a quick and easy means of disposing of any or all waste matter which can be carried away by the sewer without any consideration whatsoever of the effect of such discharge, either upon the structure itself, its maintenance or operation. The transition in the mode of travel from horse-driven vehicles to the motor-driven car and truck renders the transportation, handling and use of large quantities of gasoline necessary and it is inevitable that in the handling of this material some will be spilled or wasted either by accident or design, which will find its way into the sewers.

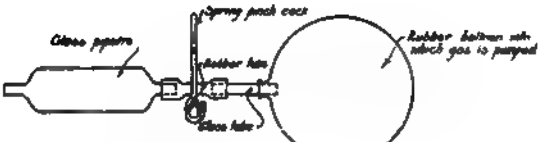
There are many sources which contribute inflammable wastes in a greater or less degree, ranging from the small and irregular discharges from households and private garages,

which may amount to considerable in the aggregate, to the large and intermittent discharges from manufacturing and storage plants and other enterprises which use large quantities of gasoline.

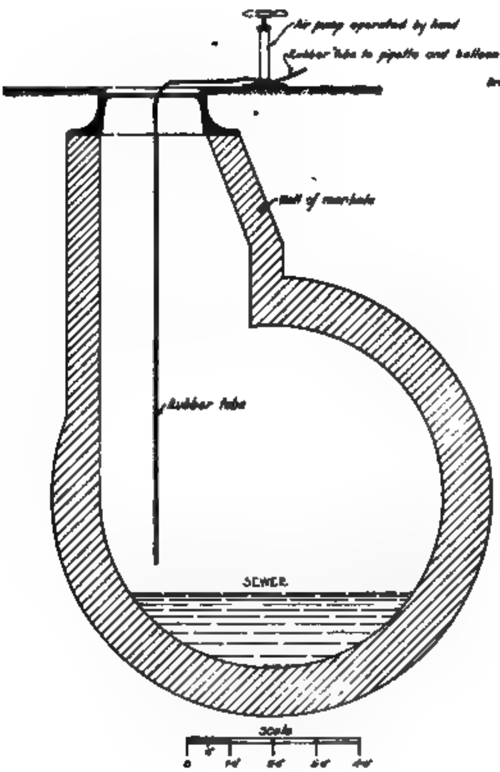
In some cities (Pittsburgh included) the laws relating to the storage of gasoline require the tanks to be buried in the ground. These tanks, which are made of riveted steel plates, vary in capacity from about 50 to 15,000 gallons. The purpose of placing them underground is to prevent possible ignition of the gas and protect them in case of a nearby fire. It is not the author's intention to discuss the advisability or the objection to placing gasoline storage tanks underground, but simply to point out the possible danger of gasoline escaping from these tanks and entering the sewers. The thickness of the steel plates of which the tanks are made, is generally from 1/8-inch to 3/16-inch and their only protection from corrosion is the application of ordinary structural paint. The tanks are laid directly upon the ground and then covered with earth. Under such conditions, corrosion is rapid. It is also possible, under favorable conditions, that the tanks may suffer injury due to electrolytic action. In any case, there is no opportunity for inspection or repairs and leaks can only be detected by making a comparison of the quantity of gasoline put into the tank with the quantity removed. This information is in the possession of the owners and in case a leak is disclosed by a comparison of the figures, the owners are not likely to volunteer the information to the public authorities.

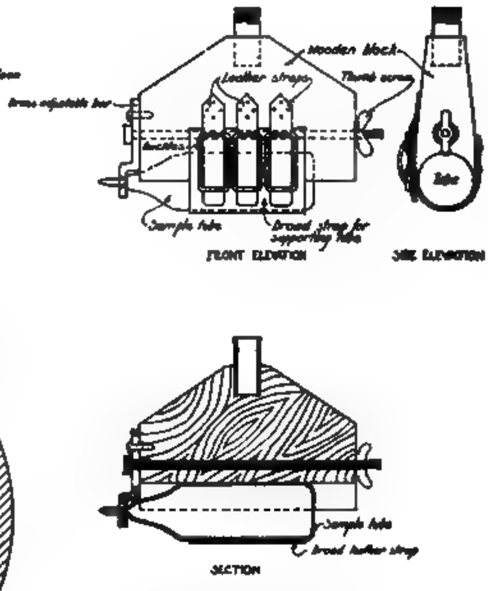
The possibility of gasoline escaping from the tanks into the ground and finding its way into the sewers may be remote, but with pervious soil or a near-by catch-basin or trap, the opportunity for leakage into the sewers is at least present. In certain locations it is quite possible to set these tanks above ground, where ample opportunity for inspection and repairs would be possible. The waste gasoline from households, private garages and shops is so well distributed throughout the lateral sewer system and the average amount discharged


ALLEGHENY RIVER
CREST LINE
LEGEND
CITY OF PITTSBURGH
DEPARTMENT OF PUBLIC WORKS
BUREAU OF ENGINEERING
THIRTY-THIRD ST. DRAINAGE BASIN
SEWER EXPLOSION INVESTIGATION. LOCATION OF STRUCTURES HANDLING INFLAMMABLE AND EXPLOSIVE MATERIALS.



SKETCH OF PIPETTE AND BALLOON
scale





SKETCH OF APPARATUS FOR COLLECTING GAS SAMPLES FOR ANALYSIS
scale

CITY OF PITTSBURGH
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BUREAU OF ENGINEERING
SEWER EXPLOSION INVESTIGATION
APPARATUS FOR TAKING SAMPLES OF AIR
INSIDE OF SEWER

at any one time so small that it is quickly dissipated before the formation of explosive vapors can occur. It is therefore to be supposed that the formation of gasoline vapor and other explosive gases present in sewers originates from establishments which are large users or dealers in inflammable materials.

There being in most cases no laws prohibiting the discharge of inflammable wastes into the sewers and the danger of such practice not generally understood, the natural disposition of such wastes is into the sewers. These wastes comprise dirty and used gasoline, benzine, oil, washings from tanks, and refuse from gas plants, paint works, etc. The quantity of these waste products varies according to the magnitude of business and methods employed.

While the discharge of gasoline into the public sewers probably exceeds in quantity any other inflammable waste, yet the discharge of waste products from paint works, oil refineries, gas works, etc., is likely to produce conditions, which, under favorable circumstances, may fill the sewer with explosive gas. Ignition of explosive gases, when present in the sewers, may occur in many different ways—for instance: sparks from street railway tracks, hot cinders and sparks from locomotives, stacks, etc., which may enter the manholes through the perforations in the covers, or when same are removed for inspection or repairs; also the dropping of matches or lighted cigars into manholes or catch-basins; lights and sparks from tools, while making inspection or repairs within the sewer or at chambers, pumping stations or disposal plants.

The problem of preventing sewer explosions would then seem to be a question of either effectually sealing all openings into sewers or excluding or regulating the discharge of inflammable or explosive wastes.

A number of cities have attempted to solve the problem by procuring legislation prohibiting or regulating the discharge of inflammable waste materials into the sewers. Prior to the general use of motor vehicles there were many industrial and business establishments using inflammable and volatile wastes,

such as dry cleaning establishments, paint manufactories, gas works, etc. Notwithstanding the fact, explosions in sewers caused by the ignition of gasoline vapor were uncommon. This fact would seem to indicate that the greatly increased use of gasoline due to the growth of the automobile industry has been responsible for many of the recent sewer explosions.

Accepting this theory as a working basis, we must determine whether or not the gasoline is discharging into the sewers in large quantities by a relatively few people or in small quantities by a great number. In the first case the situation is relatively easy to control, while in the latter, it would be difficult. Moreover, it is necessary and important to determine whether the explosive vapor is generated from the accumulative effect of a great number of small discharges or from the discharge of large doses. Past experience has shown that the ordinary means of providing ventilation in sewerage systems has been generally adequate to prevent the collection of explosive gases. If large doses of inflammable wastes are allowed to enter the sewers, other means of ventilation will have to be provided or the sewers sealed. The installation of mechanical ventilation in the sewers throughout the system would remove the gases, but would involve great initial outlay and the cost of maintenance and operation would generally be prohibitive. This scheme would not seem practicable. There is no practical way of providing sufficient ventilation either by mechanical or natural means which would exhaust the air inside the sewer quickly enough to prevent the formation of an explosive compound, in case large quantities of gasoline were present in the sewer. With the exclusion of large discharges of gasoline into the sewers, the danger of explosions can be greatly lessened by giving more attention to the improvement of the natural ventilation. This would probably be sufficient to prevent the collection of explosive vapors arising from the normal amount of gasoline discharged into the sewers. To form an explosive mixture a certain amount of air and gas is required. If there is a shortage of gas or an excess of air, no explosion can occur.

It cannot be ignored that many sewer explosions have resulted from the leakage of natural or artificial gas into the sewers. Evidence has been conclusive in a sufficient number of cases to show unmistakably that this is a fact. The prevention of explosions from this source, however, is well within the jurisdiction of public officials and the remedy is the tight construction of sewers and proper laying and location of gas pipes. The remedy in this case consists, therefore, in the enforcement of powers that municipalities at present possess.

Modern sewer design provides for the ventilation and inspection of the structure. The discharge of inflammable wastes into sewer systems would not of itself be a serious matter, or objectionable, were it not for the possibilities of igniting the explosive compounds. Ignition of gases in the sewers could be prevented by sealing all openings, but this would prevent inspection and create impossible working conditions inside the sewer when repairs became necessary. Moreover, the sealing of the sewers would not prevent ignition at chambers, pumping stations and disposal plants. In addition to the foregoing, there are other reasons which would make the sealing of the sewers impracticable and inadvisable.

The exclusion of inflammable wastes from a sewer system brings up the question of how it shall be accomplished. The regulations of the Municipal Explosives Commission of the city of New York, adopted January 3rd, 1912, require the installation of oil separator traps or similar apparatus. The city of Boston requires a special trap which will prevent the discharge of the objectionable wastes into the sewers, and the city of Chicago has somewhat similar regulations to those of New York, governing this matter.

The efficiency of these devices is dependent upon the attention paid to their operation by the individual. Careless operation or neglect might render them of little value and defeat the purpose for which they were installed. Therefore, frequent inspection should be made by the proper public officers. Their general use on all sewer connections where gasoline or other

inflammable waste is discharged would seem prohibitive, if found advisable, on account of the cost. The compulsory installation of devices for removing oil will generally meet with opposition by those affected, which has been recently demonstrated by the passage of an ordinance in New York City repealing the ordinance requiring the installation of oil separators. I am informed that this repealing ordinance was vetoed by the mayor.

Formulation of legislation directed toward the prohibition of the discharge of inflammable wastes into sewers is at present receiving attention in many cities. That the same may be effectual requires the most careful consideration. It is most desirable that the necessity for such regulations be demonstrated and the efficiency of any devices thoroughly proven before they are required by ordinance.

The writer has examined the regulations of a number of cities and has come to the conclusion that it would be best from the standpoint of enforcement, to have all regulations of this nature contained in a single ordinance which would cover all phases of the discharge of wastes of all descriptions into the sewers. Such an ordinance should contain the following:

A. Prohibition against the discharge of any inflammable gas, volatile inflammable liquid, inflammable liquid, oil or gas, or any calcium carbide or residue therefrom, or any liquid or other material or substance containing inflammable gas or which would evolve an inflammable gas when in contact with water or sewage.

B. Regulations as to how sewer connections with establishments from which the foregoing wastes emanate may be made. This may or may not require the installation of special traps, separators or similar devices.

C. Provision for the examination and approval of all intercepting devices and provision for their inspection, maintenance and operation.

D. Provision with regard to the discharge or placing of obstructing material in any part of the sewer system.

E. Regulations as to the discharge of steam or hot liquid or gaseous waste into the sewers.

F. Regulating the location of gas pipes in city streets with reference to the sewer; prohibiting the placing of gas pipes close to or within the masonry of sewers.

G. Prohibiting connections from manholes, gate boxes, or other apparatus of public service corporations to the sewers, except in an approved manner and when properly trapped.

Legislation alone will not secure or prevent the discharge of these objectionable wastes into sewer systems, but by informing the people of the damage resulting from this practice, the offense will be greatly lessened.

It would appear desirable, in the interest of public safety, where oil separators or similar devices are installed, for the municipality to undertake the final disposition of the residue rather than entrust it to the individual. The importance of the problem and the necessity for its strict and effectual regulation has been amply and forcefully demonstrated by recent violent and destructive explosions.

As recently as September 22nd, another serious explosion curred in the sewer on East 42nd street, between 3rd avenue and the East river, making the third explosion in the same sewer within a year. Reports state that the physical damage to the sewer, buildings and street, was not extensive. This is accounted for by the fact that the sewer was a brick lined tunnel in rock about forty (40) feet below the street surface. Under less favorable conditions of location and design this result would have been far more serious.

The most disastrous and expensive sewer explosion up to the present time, although entailing no loss of life, occurred at Pittsburgh, Pa., November 25th, 1913. This explosion to date has cost the city about $300,000.00, which may be increased by possible damage suits.

This problem is not confined to the prevention of explosions in the sewers themselves, but may extend to all kinds of sewerage works as shown by the explosion in the screen chamber at

East Boston, which occurred June 1st of this year. In this explosion, which was caused by the presence of gasoline vapor, six lives were lost and three men severely injured.

Without mention of other recent sewer explosions, it is evident from experience covering many cities, that an immediate, effectual and permanent remedy must be found to control the situation. With three explosions in the 42nd street sewer in New York and two in the 33rd street sewer in Pittsburgh, all within less than a year of each other, there can be no question but what the conditions inside of all large sewers draining garages, etc., are such as to produce explosions wherever ignition occurs. The safety of the public and the welfare of the community are therefore now dependent more upon good fortune than the certainty of scientific control, hence the public is always exposed to the hidden danger which only requires a chance spark to cause havoc and disaster. The present situation can be likened to the man sitting on a keg of powder.

The city of Pittsburgh, immediately after the second explosion, set about to make an investigation and study with a view of preventing a repetition of such disasters. This investigation is being conducted jointly by the city and the local office of the U. S. Bureau of Mines, who have rendered valuable assistance and advice.

The purpose of this investigation, which is still in progress is:

First: To locate all possible sources from which gasoline or other explosive wastes might enter the sewers.

Second: To determine by a series of examinations and tests the location of the sources where the waste was discharged.

Third: The determination of the presence, extent and quantity of vapor within the sewers.

Fourth: Experiments to determine the effect and behavior of gasoline dumped into the sewer in different quantities and at different intervals.

The 33rd street drainage basin was selected for study because of the number of garages within the basin and the fact that two explosions have already occurred, indicating the discharge of large quantities of explosive waste into the sewer.

The 33rd street drainage basin has an area of 1,642 acres, a population of 53,785, and a total of 417 structures where inflammable and explosive materials are handled. These structures are classified as follows:

295 Small garages, not more than two cars, includes private and small business garages.

67 Large garages, not less than three cars, includes public garages, repair shops, large business garages, etc.

12 Gasoline storage establishments.

1 Dry cleaning establishment.

2 Paint shops.

39 Business or manufacturing places where inflammable oil or gases are manufactured, used, sold, handled or washed; includes gasoline supply establishments, large automobile establishments where gasoline is stored, sold and used in large quantities.

A map was prepared showing the outline of the basin, the sewer system within and the location of all garages, dry cleaning establishments and other places where inflammable or explosive wastes are likely to be discharged into the sewers. The map will be used in connection with studies to locate the point or points where the discharge of inflammable wastes occur.

Letters of inquiry were sent to all the principal cities in the country with a view of obtaining data and information relative to sewer explosions and what laws or ordinances were in force regulating or controlling the discharge of inflammable or explosive wastes into the sewerage systems. The answers received in reply to these inquiries were compiled and have been printed in pamphlet form and copies furnished to each city supplying information.

Apparatus was designed for securing samples of air within the sewer and for making field tests of same. The apparatus used is shown upon the accompanying plan.

The results so far secured in the investigation indicate the presence of gasoline vapor in the sewers of both the 33rd street

and Negley Run systems. This latter system drains an area of about 2,500 acres with a population of about 50,000, and there are considerably less sources from which inflammable wastes are discharged than in the 33rd street system. Analyses of a series of samples taken on the same day at various points in these systems have shown that gasoline vapor in small amounts is present throughout the sewer system. The gasoline vapor ranges from 0.012 to 0.065 per cent. of the volume of sewer air in the sample. While these percentages of gasoline vapor are considerably below the danger mark, which may be taken as 2 per cent., it goes to show that the natural ventilation of these sewer systems is not sufficient to remove the effects of the ordinary or normal discharge of gasoline.

The Negley Run system drains through duplicate outlet sewers for a distance of over a mile, during which distance there are no connections known which could by any possibility discharge gasoline. Above this point, there are a number of large branch sewers of considerable length so that taking these larger sewers of the system together with the many miles of laterals, with the opportunity for ventilation provided, it must follow that natural ventilation would not suffice to remove the effects of the discharge of gasoline in large doses.

It is expected that these experiments will require considerable time before definite conclusions can be reached and preventive measures, based upon same, can be formulated.

DISCUSSION.

George H. Norton (by letter): One phase of possible danger to sewers has had little public discussion. While conditions here noted may have no material bearing they are at least worthy of consideration.

In the city of Buffalo, N. Y., a 36-inch brick sewer has its outlet into a storm drain, submerged at times, and its dry weather flow is intercepted a short distance above. Over two years ago serious complaint came from some business places of the odors of gas in buildings evidently coming from the sewer.

Investigation showed that this gas or odor undoubtedly came from a "hydro-carbon" oil used in the railroad yards of an adjacent station. This oil is poured on switches and interlocking devices in a blazing condition during heavy snow storms and in extreme cold weather to prevent freezing and obstruction of these movable parts by snow and ice. The odor of gas in the sewer followed a thaw when evidently some of this oil, which had not been consumed, was floated into the yard drains and thence into the sewer. There were two repetitions of this condition, the last one being the most extended, when occupants were driven from several buildings along the line of this sewer by fear of explosions within the buildings. All manhole covers were removed and no explosion occurred in the sewer. The noticeable feature was that this gas or odor seemed to pass through the water sealed sewer traps of these buildings with little hindrance on all three occasions. An experienced chemist made examination of this oil and reports that portions of it will crystalize at low temperature and that these crystals are soluble in water. This may offer a possible explanation of the odors or gas passing water-sealed traps. This oil is said to be a by-product of Pintsch gas manufacture. The use of this oil has been discontinued in this railroad yard.

Similar conditions of railroad yards have existed in the vicinity of sewers in other cities where explosions have occurred, and while little seems known of this material it may well be worth further study and examination.

Mr. Macallum: We had five explosions last winter, one in a sewer manhole, one in a waterworks manhole that had just been built, where two men were removing the shoring of the concrete; and three in private houses, in basements. We found the ground had been frozen around the gas pipes, and the mains had leaked, and it had gotten into houses where gas was not used at all. There was another case in Toronto, where an engineer was down in one of the trunk sewers, and he was overcome there and died, and that also was caused by a gas main.

PERMANENT SEDIMENT RECORDS FOR WATER AND SEWAGE.

By GEORGE C. WHIPPLE, *Professor of Sanitary Engineering, Harvard University and the Massachusetts Institute of Technology, Consulting Engineer, New York City, and* JOHN W. M. BUNKER, *Instructor in Sanitary Analysis, Harvard University.*

In spite of all that has been said and written on the subject of water analysis and in spite of the fact that hundreds of samples of water and sewage are being analyzed every day, it still remains true that the results of the analyses are unintelligible to a large proportion of the people who are interested in the general subject, and I might add to a great many of those who make the analyses. The interpretation of a water analysis we have been told over and over again is a matter for the expert.

Yet there are some characteristics of water that are evident to layman and expert alike—the conspicuous physical characteristics of color and turbidity, taste and smell. Within recent years tests for these properties have been simplified and standardized, but simple as they are the results cannot be understood by one who does not know the scales of measurement. There is often needed some means of bringing to people's attention the character of a public water supply or the condition of water in a stream, or that of a sewage effluent, and this must be done by appealing to something within their everyday experience, by presenting something that they can see or smell or taste. Such a something is dirt.

Every citizen desires a supply of clean water. If the water supply is dirty it fails to give satisfaction, and any method which will exhibit its dirtiness will appeal to a universal in-

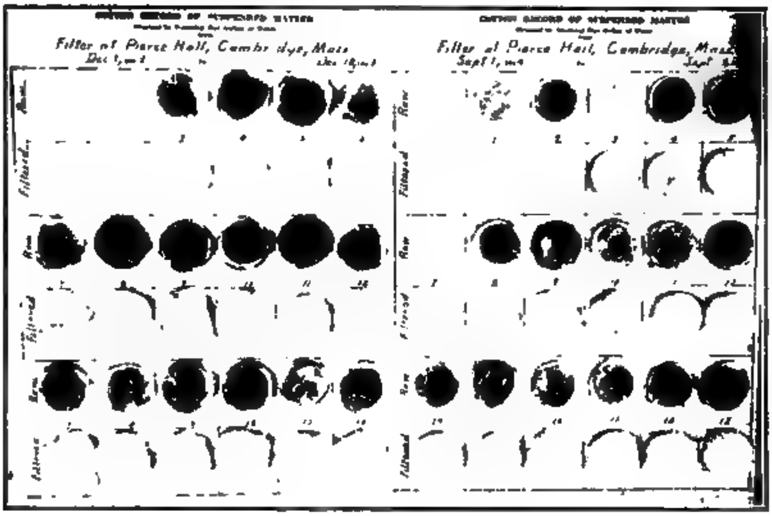

Fig. 1. Cotton records of suspended matter strained from one gallon each of water from filter at Pierce Hall, Cambridge, Mass.

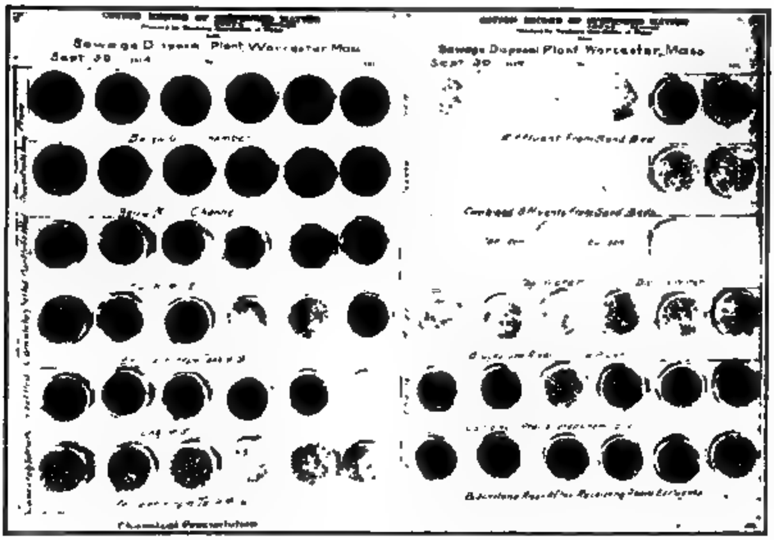

Fig. 2. Cotton records of suspended matter strained from one gallon each of sewage in various stages of purification in the sewage disposal plant at Worcester, Mass.

Fig. 3. Cotton records of suspended matter strained from one gallon each of water taken at various depths from Lake Cochituate.

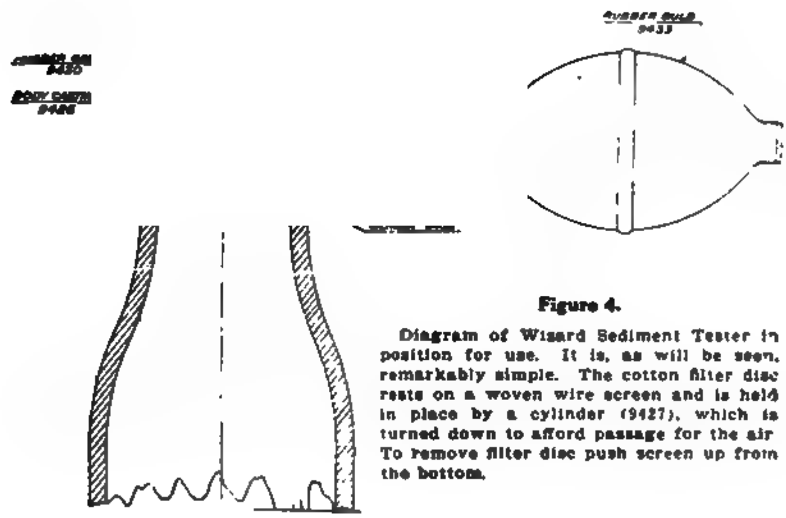

Figure 4.

Diagram of Wizard Sediment Tester in position for use. It is, as will be seen, remarkably simple. The cotton filter disc rests on a woven wire screen and is held in place by a cylinder (9427), which is turned down to afford passage for the air To remove filter disc push screen up from the bottom.

stinct and experience. We all desire clean waterways. We believe that the final effluents from sewage treatment works should be reasonably clean—otherwise why treat the sewage—and any method which will exhibit the dirtiness of the water in a stream or in a sewer will prove a useful weapon in the fight for cleanliness which is being continually waged by sanitarians.

There are various forms of dirt found in water and sewage, if by dirt we mean substances which pollute or make foul. Some forms of dirt are in solution, or are present as colloidal substances, or as excessively fine particles. These require special tests, special methods of comparison and exhibition of results. But there is one form of evident dirt for which we have thus far had no satisfactory measure, namely, the coarser forms of suspended matter. Our methods of measuring turbidity do not adequately depict the presence of the larger particles of obvious dirt. They are largely optical and the larger particles of suspended matter do not greatly interfere with the passage of light through water unless they are quite numerous, hence they escape being recorded. A simpler method with more direct and picturesque results is needed. Such a plan is the one about to be described. It is not original, being merely an adaption of a method already in wide use for exhibiting and recording the amount of sediment in milk.

The method consists merely in straining a given volume of water, say one gallon, through a disc of absorbent cotton, about one inch in diameter, and especially prepared for the purpose. This is most conveniently done by means of a simple apparatus known as the "Wizard Sediment Tester," which is made by the Creamery Package Manufacturing Company of Albany, New York. The cotton disc, which is the filtering medium, is held between two supports of wire cloth in a cap attached to an ordinary glass milk bottle. The water to be filtered is placed in the bottle and allowed to flow out through the cotton disc. Filtration is hastened by increasing the pressure of the air within the bottle by the use of a simple air compressor

operated by a hand bulb. In order to filter a gallon of water the bottle has to be filled four times. The accompanying figures show the details of the apparatus.

This particular form of apparatus is not necessary. Other similar sediment testers are on the market. Nor is it necessary to use compressed air in filtering. A gravity flow will give the same result, or a flow hastened by centrifugal force or by the water pressure of the city mains. All of these methods have been used in the laboratory of sanitary engineering at Harvard University.

The coarse sediment in the water is retained in the pores of the cotton disc and remains as a permanent record which readily appeals to the eye and which by its appearance gives at once a good idea of the quantity and character of the substances present. For permanent record it is well to provide sheets or cards to which the cotton discs may be easily attached after drying by using a drop of mucilage or a little paste. The suspended matter does not change in appearance even after a long time, and does not shake off unless too much sediment is allowed to collect. For the sake of uniformity the writers suggest that the following table be accepted as a tentative standard for quantities of water to be filtered:

STANDARD QUANTITIES FOR FILTRATION THROUGH COTTON DISCS.

Filtered Water	one gallon
Ground Water	one gallon
"Clean" Surface Water	one quart
"Dirty" Surface Water	one pint
Sewage, and Sewage Effluents	one-half pint

While the metric units of measurements are more scientific than the commonly used units of liquid measures, the latter are better comprehended by the public, and are more appropriate for this crude test.

The quantity to be filtered varies with different waters. It is advisable to filter the smallest quantity that will give a

definite record, inasmuch as increased quantities tend to pile up the sediment on top of the first layer and therefore do not show small variations. A water rich in algae will produce a definite stain on a cotton disc after one quart has passed through. A clean water does not leave any noticeable discoloration when this amount is filtered but may color the disc slightly when a larger sample is taken for the test. A typical crude sewage, on the other hand, will clog the disc when from 50 to 200 cubic centimeters have been strained, and more can be forced through only with great difficulty. The best of sewage effluents will give some discoloration when this quantity has been filtered, so that a ready comparison is possible.

The following are a few illustrations of the use of the cotton disc method for collecting sediment:

Samples of the sediment found in the tap water of Cambridge, Mass., have been taken almost every day for more than a year. The cotton discs record the changes in the growths of algae with striking picturesqueness. In summer when the chlorophyceae are abundant the stain on the cotton disc has a bright green color. During the ascendency of the cyanophyceae, in the "dog days," the color is a slaty bluish green. The quantity of sediment fluctuates somewhat from day to day as the wind blows the algae from one side of the reservoir to the other and as the algae rise or fall in the water. In the spring the sediment has a brownish color due to the presence of diatoms. Samples of water collected at different depths show very distinctly the distribution of the algae in a vertical direction from top to bottom. Normally the algae are most abundant at the surface but decrease with greater depths. The samples at the bottom often show the presence of a brown colored sediment due to the influence of the organic matter and iron found in the stagnant layers.

Any departure from the normal distribution is quickly noted by this method of examination, as is shown by the set of discs made at Lake Cochituate on October 2, 1914. This series shows a steady decrease in depth of color down to the transi-

tion zone at which point there is a darkening of the discs, due no doubt to a concentration of organisms at this point. Immediately below this organisms fall off and again increase gradually until the forty-five foot level is reached. The last fifteen feet, from the forty-five foot depth to the bottom, shows the presence of a different kind of sediment, darker in color and more abundant in quantity, in which iron is present in large amounts.

On some days the amount of sediment in the Cambridge water has been found to suddenly increase owing to the disturbance of deposits in the pipes. The character of this sediment is quite different from that normally found. Again samples taken from the hot and cold water taps often show marked differences, the hot-water sediments showing the presence of iron rust derived from the action of the water on the heater or the piping in the houses.

The method is particularly well adapted to show the effect of filtration on dirty water. During the past year an experimental mechanical filter has been in operation at the laboratory of sanitary engineering, Harvard University, and daily records have been kept of the sediment in the water before and after filtration. The results are often more striking than the figures which show the removal of bacteria. On certain days when the filter was not operating at its best the cotton discs through which the filtered water passed were slightly discolored.

Mr. Clifton L. Rice, who has been recently assisting Mr. Frank A. Barbour in a series of valuable experiments on the purification of the water at Lowell, Mass., has used the cotton disc method with marked success. Mr. Barbour's report shows photographs of the sediment collected on the cotton discs. The problem there is the removal of iron and manganese from the water. The efficiency of the purification processes which it is proposed to employ is well indicated by the stains made by the raw water and the absence of stain when treated water is passed through the cotton.

Professor Robert Spurr Weston recently exhibited to the New England Water Works Association some series of samples showing the removal of iron and manganese from other water supplies of Massachusetts by filtration.

The cotton disc sediment record has the following advantages:

1. It can be made very easily and quickly.
2. It can be made by the laborer and the office boy as well as by the engineer or chemist.
3. It is inexpensive.
4. The records are picturesque and easily understood by every one.
5. Within limits the records are quantitative as well as qualitative. They serve well for comparing samples from the same place on different dates.
6. The records are permanent.
7. The records may be conveniently mounted for preservation.
8. The records may be photographed.
9. A relatively large volume of water is tested.
10. It is a valuable supplement to the regular water analysis.

REPORT OF THE COMMITTEE ON TRAFFIC ON STREETS.

Louis L. Tribus, *Chairman, New York City.*

Your Committee on "Traffic on Streets" has had more or less individually to do with the subject, but like many others has found it difficult to gather effective information or shape up any world startling report, but will submit some items that may serve as topics for discussion or pave the way for more complete and effective work later.

From his wide responsibilities in the city of delicious water, high winds and great activities, Mr. John B. Hittell, Chief Street Engineer of Chicago, presents the following items of interest:

The matter of street traffic from an engineering point is closely allied with that of the police power of a city.

A Sub-Committee of the Chicago City Council's Committee on Local Transportation has been given the task of preparing an ordinance for regulation of motor trucks and other vehicles; to this work the Municipal Librarian is giving large aid from the data he has gathered from all sources.

The Chief Engineer of the Board of Estimate of New York and the Consulting Engineers of its five boros, acting as a Board, prepared a careful sliding scale regulating ordinance covering licenses for gross weight, weights per wheel, weight per inch width of tire, width of vehicle, etc.

The New York Board of Aldermen did not take kindly to some of the features, however, so, apparently advised by Corporation Counsel, has, as yet, failed to pass any adequate set of rules.

General ordinances covering load, widths of tire, maximum speed and width of vehicles, have been promulgated in Boston, Buffalo, Cleveland, Cincinnati, San Francisco, Minneapolis,

Washington, Los Angeles, Providence, Cambridge, Oakland and London, England; also in many less conspicuous places.

It is a problem how paving engineers are going to meet the conditions brought about by the heavily laden and rapidly driven motor vehicles.

In the larger cities, widths of street available to traffic are now well nigh rigidly fixed, especially in those districts where motor vehicles abound, as is frequently the case also of spaces between curbs and car tracks. In Chicago, this is sixteen (16) feet in the loop district. Congestion of street traffic and pedestrian travel will be the factors determining speed.

In many of Chicago's bituminous roads and other pavements, subjected to rubber tired wheel traffic, it is being noted that the surface is rutting badly; the question arises whether that may not be due as much to the disintegrating action of friction heat as to dripping oils, in destroying the qualities of the cementing media.

Many other problems are before us. All the information that can be secured thru experiment, observation and discussion will be of great value in their solution.

The Efficiency Division of the Chicago Civil Service Commission made during 1912-1913 a traffic census in the district bounded by 12th street on the south, Chicago avenue on the north, Halstead street on the west and Lake Michigan on the east. This covered respectively the total numbers of teams and motors passing north and south at some 93 intersections and east and west at some 102 points, upon varying dates between August, 1912, and October, 1913.

In some cases the travel each way was noted, but generally the combined tallies were taken.

The winter season months, November and February, were omitted from observations.

Indicating perhaps varying weather conditions and some abnormalties of travel the count during the hours 8 to 12 mornings and 12:30 to 4:30 afternoons yielded figures as follows:

EAST AND WEST TRAVEL.

	Range	Total average	Average per hour
Horse drawn	35 to 4,496	1,218	152
Motors	3 to 3,191	358	45

NORTH AND SOUTH TRAVEL.

	Range	Total average	Average per hour
Horse drawn	225 to 3,341	1,448	181
Motors	12 to 4,650	351	44

The idea controlling the census seems to have been more for "congestion" as influencing width of roadways, than for effect on pavements.

Another Traffic Census, conducted by the Bureau of Streets, on dates March 25-29, 1913, included in its data, taken from 7 A. M. to 6 P. M.:

Horse drawn vehicles
Motor driven vehicles
Pedestrians
Street cars
} Each for each direction.

Kind and condition of pavement
Width of Street
Weather

The weather included sunshine, dryness, rain, sleet, snow.

Averages for the 18 counts east and west and 6 counts north and south respectively, yielded the following:

EAST AND WEST TRAVEL.

	Range	Total average	Average per hour
Horse drawn	1,072 to 5,340	2,727	248
Motor driven	131 to 4,297	900	82
Pedestrians	2,516 to 39,971	13,450	1,223
Street cars	185 to 1,277	673	61

NORTH AND SOUTH TRAVEL.

	Range	Total average	Average per hour
Horse drawn	1,116 to 1,984	1,646	150
Motor driven	152 to 717	461	42
Pedestrians	2,857 to 19,218	9,086	826

Very naturally a comparison of the two sets of counts will vary considerably, the first series taking in many intersections of light travel; the second set only a few of the busier ones.

For "congestion" which affects width of roadway study must be made of the intensity and hours of travel and its character, but for a paper of this nature such analysis is out of place except by reference and all of the figures must be taken as suggestive of how some information is gathered. Chicago hopes to gain much from more studies along similar lines.

The chairman talks or dictates an essay, upon the least provocation, tho in sanest moods usually consigns the written word to the waste basket. Apparently, however, duty calls for some "street traffic" comments, so the office waste basket will not be immediately requisitioned.

Until very recent years, the character of street pavements in cities, outside of a few of the more important and heavily traveled thoroughfares, depended rather more on whim of the "City Fathers" and the availability of funds, than upon economic value.

Expert representatives of various pavement firms and supply houses were also very "persuasive" influences.

The engineer was virtually limited to the preparation of specifications to accord with these well grafted ideas; to give grades and supervise the work. The grafting of ideas was not by any means always, in a dishonorable sense, but unfortunately too often so, though the engineer was usually guiltless.

Except for noise, slipperiness and first cost there was but little known reason for discriminating between pavements.

The chief injury to them came from careless replacement, after removal for substructure work and fire burns in case of asphalt pavements, hence personal preference and convenience with some attention to first cost determined the selection of countless miles of granite, brick and sheet asphalt wearing surfaces.

The power of horses and mules to pull, with the practical limits to their speed while drawing loads of varying weights,

itself guaranteed safety to the paved surface when once selected and well laid.

While hundreds of miles of pavements have failed, due to defective foundations, city engineers as a class, when in real charge, have looked fairly well after that essential feature—and appropriating officials have not often interfered with the carrying out of a good intent, backed up by professional opinion.

With the coming of the power street vehicle has grown the specialty of highway engineering. From normal loads of 3 tons maximum per vehicle, three and four times three are of daily occurrence in every sizeable town; from maximum speed for 3 ton loads, of 4 miles per hour, now is found 12 to 15 miles or greater and 6 or 8 miles for the heaviest loads.

In contrast to the smooth traction of rolling wheels, pulled by horses, with scarcely perceptible damage, comes the terrific, tearing push and kick of the motor wheels, doing more damage in making one start of a heavy load than a hundred starts of horse pulled wagons.

As these motor vehicles increased in weight and numbers with almost inconceivable rapidity, came the complete and rapid destruction of countless miles of pavements, not adapted for such service. Without time therefore for the best of study and experiment pavement engineers were at once compelled to theorize and build or more often even reverse the process.

The writer, having peculiarly fortuitous circumstances of friendly and liberal appropriating bodies, virtual carte blanche from the administration, and loyal and intelligent engineering assistants, began in 1902 to study the conditions making for the life economy and efficiency of street pavements.

It is not the intention of this report to review the work in such lines of the succeeding twelve years, but the mere list of pavements laid and processes tried in the Boro of Richmond, City of New York, may be of interest:

Trap blocks—large and small cut (Belgian).

Granite—old specifications—new close cut (brick shaped) napped halves and small cubes.

Medina sandstone.

Iron slag bricks—(imported).

Vitrified bricks—several kinds.

Wooden creosoted blocks.

Asphalt blocks—varying thickness.

Sheet asphalt.

Portland concrete.

Bituminous concrete.

Bituminous Macadam—Pre-mixed and Penetration with various asphaltic oils.

Oil concrete.

Westrumite.

Oil sprayed Macadam and various dust layers.

Water bound Macadam—thick and thin.

The pavements from Trap to Sheet Asphalt were almost all tried out, with concrete foundations, old Macadam foundations and for the first three, sand beds also.

So far as possible each pavement was tried under two or three different conditions, such as seemed most likely to be the most suitable, and of lengths to insure adequate trial, usually in at least half mile stretches.

There were considered as factors in first selection of type, district, business or residential traffic, heavy, medium, light, grade.

Protection—by shade or from strong winds.

Foundation—dry or wet.

These involved noise, slipperiness, ready repair, appearance, dust and lastly first cost.

As years proceeded, some knowledge was gained from the earlier work and some preconceived notions went to the scrap-heap, with some of the money invested, but perhaps with result of saving much more later.

Selection by united judgment, even after study and observation at home and abroad, did not seem quite sufficient after traffic became more intense, so early in 1913 a concerted traffic

census was planned for, with the expectation of continuing same at six month intervals for several years, with very careful attention given to the condition of the different pavements at the same times, together with an absolute record of current repair and renewal costs.

The matter has gone out of the writer's control, but he hopes that the work will be continued, for he anticipates results of value, not only local but general.

For the first census twelve important stations were selected, and at five of them observations were also taken for branch incoming and outgoing traffic, making therefore 17 sets of tallies and notes.

The statistics covered from 8 A. M. to 6 P. M. on Friday, July 25, 1913.

Saturday, August 2d.

Sunday, August 10th.

Monday, August 18th.

Tuesday, August 26th.

Wednesday, September 3d.

Thursday, September 11th.

This gave a fair average of weather conditions and a pretty good average of travel for the summer season.

The recorders noted:

Direction of travel for loaded and empties; of value in determining gradient of road (of purely local importance).

Kind of Traffic—affecting speed—therefore width of roadway, as well as grade and roughness.

Weight of Traffic.

Important for kind of pavement and foundation.

Weather and temperature conditions were also noted.

The two observers at each point tallied alternately each for 15 minutes, so that full relief was given—from at times very strenuous observation and tallying.

These 15-minute sheets were turned into the office for full tabulation, calculation and averaging.

The sheets showed record in appropriate columns of
Direction of travel.
Empty vehicles.
Half loaded vehicles.
Fully loaded vehicles.
Rubber tired vehicles.
Steel tired vehicles.
One horse vehicles.
Two horse vehicles.
Three horse vehicles.
Four horse vehicles.
Small auto trucks.
Large auto trucks.
Touring cars.
Motor cycles.
Street cars (electric).

The resulting summary sheets when worked up showed for the different stations, approaches to ferries, vicinity of manufacturing plants, general business districts and closely built up residential areas; the following average figures for ten (10) hours—Summer season traffic:

Observation Station	No. of Free moving vehicles	Electric cars	Total No.	Weight of vehicles excluding cars
A-1	210	168	378	491
A-2	90	...	90	196
B	553	406	959	1156
C	586	406	992	1193
D	[illegible]	63	561	887
E	451	69	520	808
F	594	258	852	1377
G	1070	641	1711	2282
H-1	1303	207	1510	3028
H-2	652	...	652	1827
I-1	933	207	1140	1754
I-2	246	...	246	814
J-1	789	328	1117	1747
J-2	356	328	684	738
J-3	433	...	433	951
K	606	...	606	1120
L	415	..	415	785

From an examination of the summary tally sheets an idea of speed could also be gained, a factor of importance, but not one of much benefit shown by an average.

Traffic conditions in the Boro of Richmond are somewhat similar to those obtaining in a walled city with gates; the ferries to Brooklyn and Manhattan being close together, those to Bergen Point, Elizabeth and Tottenville, widely separated, but each marking the concentration of much travel and some of it of the heaviest and also the speediest characters. The writer would not care to actually select a pavement or determine a working grade or a street width, upon a traffic census alone, but would be very glad to have such information at hand as an aid to the selection. So as chairman of the "Traffic" Committee presents the foregoing notes as his personal quota to the report.

REPORT OF COMMITTEE ON FIRE PREVENTION

ALCIDE CHAUSSÉ, *Chairman, Montreal, Canada.*

At the Convention of the American Society of Municipal Improvements held at Wilmington, Del., last year we had the pleasure to listen to a very interesting paper on "Fire Prevention" by Mr. Powell Evans, Permanent Chairman of the Philadelphia Fire Prevention Commission, and President of the National Fire Prevention Convention at Philadelphia, and while with us he invited me to attend the First American Fire Prevention Convention which was to be held at Philadelphia, the week following our Wilmington Convention, as Chairman of your Committee on Fire Prevention, I have accepted the very amiable invitation and had the pleasure of hearing Fire Prevention discussed by the most capable men in America. The complete report of this Convention has been printed and forms a volume of nearly 550 pages of very useful reading.

As I do not want to take too much of your valuable time I will only reproduce some notes respecting the various subjects which were discussed and the resolutions adopted by the Convention, this will give you an idea of the scope and the way each subject was disposed of.

TOPIC No 1—"LOCATION" (EXPOSURE HAZARD).

NOTE—Every building, and its contents in life and property, must stand on some finite, geographical spot; and carry to, and receive from, its environing property measurable fire hazards—hence this fundamental *unit* consideration.

RESOLUTION—"It is the sense of this Convention that:

Fire is always local, originating from a definite cause in a

definite property on a definite location: hence every building—in reasonable relation to its size, character, use and the congestion of its location—should be so constructed as to prevent the passage of fire from within to without and vice versa."

TOPIC NO 2—"ZONES OF DANGER."

NOTE—The *aggregate unit* fire exposure becomes *Communal* fire exposure—hence the consideration next in order of *groups* of unit exposures.

RESOLUTION—"It is the sense of this Convention that:

Populous communities should be divided into danger zones; wherein rules reasonably limiting, defining and regulating the presence, form and use of property may be legally imposed, with due regard for the present and near prospective congestion of life and property in such areas."

TOPIC NO 3—"BUILDING CONSTRUCTION."

NOTE—On any selected site the consideration next in order is the unit *building* fire hazard—in design, specification and construction.

RESOLUTION—"It is the sense of the Convention that:

All building construction and reconstruction—having in view the present and near prospective congestion of its location and the range of occupancy proposed—should fully include in design, specifications, construction and appliances adequate safeguards against danger to life and property. All buildings should be required by law to be fitted with adequate fire exits and escapes proportioned to their human occupancy in accord with reasonable exit tests. Outside fire escapes are deemed the least desirable of all forms."

TOPIC NO 4—"BUILDING CODES."

NOTE—*The aggregate* of *unit* building construction problems becomes the like *Community* problem, or the Building Code (State or local).

RESOLUTION—"It is the sense of the Convention that:

(a) All building construction and reconstruction should be under government control, State or local, to the end that the greatest safety for the greatest number for the present and future should be assured;

(b) Each of the several States should adopt a State building code with requirements which local governing bodies may raise but not lower by local enactment, said requirements to be enforced by proper governmental machinery over all and every State;

(c) The classification of building construction is entirely one of relative ability to resist attacks by fire, and therefore in all building codes the term 'fireproof' should be replaced by 'fire-resistant,' and ordinary frame construction should be classed as 'combustible';

(d) The National Fire Protection Association is hereby requested to recommend approved standards of fire-resistant construction which may be used by States and municipalities in their respective building codes."

(Section (d) was subsequently modified in its force and intent by resolution adopted under Topic No. 8, "Compulsory Physical Standards," whereby the recommendations of the National Fire Prevention Association and other originators of standards are to refer same for approval to the Bureau of Standards of the Department of Commerce of the National Government at Washington.)

TOPIC NO. 5—"PROTECTION (PRIVATE)."

NOTE—The best located and constructed unit building is now held to need *protection* (usually water supply and/or chemicals) to reasonably assure safety against fire for the building itself as well as for its contents in life and property—hence this consideration comes next in order after the actual construction (often with it).

RESOLUTION—"It is the sense of the Convention that:

(a) Every building—for its own safety and that of its contents in life and property—should be fitted reasonably, with respect to its location, character and use, with proper mechanical aids to discover, alarm and extinguishing fire and to resist lightning; and

(b) The occupants of every building should be reasonably educated regarding the physical structure thereof, and how to leave same in a quick and orderly manner, and be organized reasonably to fight fire therein."

Topic No. 6—"Protection (Public)."

Note—*Communal* fire protection is essential in addition to all like private *unit* agencies—hence this topic in this place.

Resolution—"It is the sense of the Convention that:

(a) All communities need physically a sure water supply, broadly usable by citizens for private fire protection, under the least onerous terms—also adequate fire-fighting apparatus with proper personnel to operate same; also an adequate alarm system—all proportionate to the character, area and population of each community; and

(b) All fire-fighting forces should be efficiently organized in enduring form, under legal control and disciplined when possible; their morale and requirements should be high and solely influenced by good service considerations; and the training should be constant and adequate for efficient fire-fighting and fire prevention inspection and the purchase and maintenance of the valuable special mechanical apparatus."

Topic No. 7.—"Equipment."

Note—It is necessary to heat, light, ventilate and otherwise "equip" every unit building wherever located; and this equipment is all productive, and/or receptive, of fire hazard—hence its appropriate consideration at this point.

Resolution—"It is the sense of the Convention that:

All equipment for buildings should be adequately designed

and constructed with respect to its fire hazard—productive or receptive—and that its use should be predicated on reasonable compliance with such requirements, and should be reasonably regulated everywhere by law."

TOPIC No. 8—"COMPULSORY PHYSICAL STANDARDS."

NOTE—If the thought is sound that reasonable *enforced*, laws are necessary to control the purely physical problems of so constructing, protecting and equipping buildings as to abate fire waste, then it becomes of maximum importance to define *uniformly* and *precisely* the not unduly burdensome technical physical things required in such laws by the best experience—hence this consideration at this point.

RESOLUTION—"It is the sense of the Convention that:

In view of the growth of State laws and municipal ordinances to prevent the appalling loss of life due to fire and to control fire waste by the widespread legal imposition of physical requirements upon construction, protection and equipment of buildings, it is now important that:

(a) Physical standards on this entire subject be formulated which may be generally and legally imposed without undue hardship or cost upon the public; and

(b) That the Federal Government through its Bureau of Standards of the Department of Commerce should arrange to review such standards for approval and promulgation in uniform language to the end that they may be used by States and municipalities in laws and ordinances; and therefore be it further *Resolved:*

(c) That the National Fire Protection Association be requested through its Executive Committee to arrange for a conference of delegates, with the chairman of this convention as chairman, from the American Society for Testing Materials, the American Society of Mechanical Engineers, the Americal Society of Civil Engineers, the American Institute of Electrical Engineers, and all kindred national societies having standards

bearing on this subject, for the purpose of collecting such standards for submission to the Federal Government; and be it further *Resolved:*

(d) That the conference thus formed be requested to take the necessary steps to bring these resolutions before Congress and to secure the required legislation at the earliest opportunity."

Topic No. 9—"Occupancy" and Topic No. 10—"Annual Occupancy."

Note—Every use or "occupancy" of any building contains in itself an inherent fire hazard to that structure and its contents in life and property, and also to its environing community; hence consideration here of this danger in completed buildings.

Resolution—"It is the sense of the Convention that:

(a) The individual occupancy hazard (the relative fire hazard to life and property in any given building inherent in any given pursuit) should be definitely controlled as to construction by the building code; and as to management by proper police (or equivalent) continuous regulation to assure reasonable safety of life and property therein;

(b) The general occupancy hazard (the relative community hazard inherent in any given pursuit) should be definitely controlled in every populous community by law, which should exclude extra hazardous pursuits, and properly place and safeguard by appropriate rules permissible hazardous pursuits in their appropriate danger zone (or other like delimited area); and

(c) The control of occupancy conditions, through requirements imposed by law, is essential for the abatement of fire waste of life and property; and this control to be actual and effective should cover all property (at least in cities) and continuously——at least once annually—and upon every substantial change of tenancy, through the agency of an occupancy

license based upon competent legal inspection by the fire-fighting force or an adequate similar agency.

TOPIC No 11—"MANAGEMENT."

NOTE—The preceding topics all dealt almost exclusively with *physical* means to control and prevent fire waste. This topic considers the *moral* as well as physical subject of cleanly and orderly daily living in property and its beneficial influence in abating and controlling fire waste.

RESOLUTION—"It is the sense of the Convention that:

Based on evidence and opinions obtainable approximately one-half of all fire waste—including avoidable fires without fraud as well as arson fires—arises from ignorant, shiftless, dirty and vicious use of property (which condition causes an approximate-like proportion of sickness and immorality in all populous centers) and therefore minimum continuing requirements as to clean and orderly living and the suppression of dangerous fire-breeding nuisances (such as the snap match, dangerous smoking, careless storage of rubbish, ashes, etc.) should be imposed by law in all communities, through the agency of the police power, acting through State and municipal fire marshal (or like officials), using the active fire-fighting organization for inspections as much as possible and all volunteer aid procurable."

TOPIC No. 12—"LEGISLATION."

NOTE—This topic considers the need and scope of legislation to control fire waste.

RESOLUTION—"It is the sense of this Convention that:

While fire loss of life and property is always local in inception, its result is national in effect, and hence its control must be effected by the operation of a sum total of State and municipal laws which will suppress the range of fire hazards to an attainable minimum everywhere and all the time; and that by this course alone can the sum total of fire waste of

life and property be speedily and substantially reduced, and the cost of fire insurance (which reflects this total loss) be lessened throughout the country."

Topic No. 13—"Education."

Note—No program can succeed unless understood by, and in sympathy with, the mass of people; hence consideration here of the problem of widely informing the nation about the physical phases of fire danger and waste and the imperative need of reasonable legal regulation on the subject.

Resolution—"It is the sense of the Convention that:

Education of the public about fire danger and waste of life and property should be provided in all laws, ordinances and regulations on the subject; and all interests concerned should not only join issue in collecting accurate and authoritative data, but make equal effort to dissiminate this information regularly and continuously among all the people in readily understandable language, to the end that they may not only accept, but demand proper fire waste regulation and live in full accord therewith."

Topic No. 14—"Insurance."

Note—Despite all future effort and regulation some fire waste must continue, hence consideration here of Insurance, or the distribution financially of this waste.

Resolution—"It is the sense of this Convention that:

(a) The several States, territories and provinces should not only assure that permissible fire insurance is stable financially, but that the form of contract should be as clear, brief, explicit and sound as possible and, as nearly as may be, uniform in substance in all these jurisdictions, to the end that all such policies permitted to issue throughout the country may equally and adequately protect all citizens, including the ignorant and inexperienced; and

(b) Said jurisdictions should as nearly as possible adopt uniform regulations governing:

1. Issuance of fire policies on property.
2. Licensing of fire insurance agents and brokers, and
3. Licensing of fire insurance adjusters:

To the end that only reasonable insurance contracts will be permitted on property, and that only men of sound character will be admitted to the business of writing fire insurance and adjusting fire losses, thus discouraging arson and complicity with fraudulent losses."

Topic No. 15—"Organization."

Note—The program of the Convention was concluded by discussion of future work.

Special Topic—"Sundry Fire Hazards"

One of the sessions of the Convention was devoted to the consideration of a certain range of fire hazards which fall outside of the subjects of buildings and contents, such as Forest, Mine, Railway, Ship, etc.

The papers and discussions in the aggregate have yielded a remarkable review of this great common danger and waste to life and property, both in scope and quality.

FIRE PREVENTION.

By J. C. McCabe, *Boiler Inspector, Detroit, Mich.*

Fire prevention becomes a matter of economic importance when it costs more to have fire than to prevent it. It would appear axiomatic that the destruction of anything useful was in a sense a crime against the people as a whole.

A generation or so past, it was customary to piously ascribe the visitation of epidemics to the will of God. Sanitation and common sense have eradicated recurrent pestilence from this country. Fire loss is just as much a pestilence as bodily disease, and is amendable to control and extinction by similar processes.

Out in Michigan, the Wolverine state, once famous for the excellence of its pine trees and great number of wolves, it was customary, a generation back, to waste $2.00 worth of lumber to get a $1.00 choice board from a log. This characteristic of Americans, has, in the past, permeated all our activities. If a roadway, machine, or building was under construction, the spirit was to rush it to completion. The object was speed rather than permanency. The factors of longevity, efficiency, economy and safety were seldom considered and then only in a light and airy manner.

Our great industrial development with congested centers of population has made it a matter of much economic concern to eliminate conditions productive of accidents. Nearly all of the leading industrial concerns in the United States have organized departments with an eye to prevention of accidents of every description. In a word, "anticipation" is outflanking our economic enemy "accident." This course will eventually prove of great economic value.

It has been said: "It is not only useless, but criminal, to

pass laws which go beyond the average conscience of the community previous to educating the community to its necessity." This line of thought carries with it the well known and deplorable fact that many safety laws and regulations are made the vehicle to promote private interests. Great care must be exercised to avoid this condition.

A great spirit of co-operation is animating every line of industry in the United States. The activities of the American Society of Municipal Improvements, in its sphere of usefulness, is the prototype of other organizations wrestling with problems for the general good. I would mention the concerted effort of the boiler manufacturers of the country and the American Society of Mechanical Engineers in their effort to formulate a standard boiler inspection code for the whole United States.

The National Board of Fire Underwriters and the National Fire Protection associations have done great work to promote fire prevention. Attention is called to the admirable code called "A suggested ordinance regulating the use, handling, storage and sale of inflammable liquids and the products thereof." Legislation covering such matters is usually framed by men without expert knowledge of the subject and the regulations are necessarily drastic in part and ineffectual.

In this connection, I wish to mention that the common council of the city of Detroit has now pending before it the adoption of the code regulating the use of inflammable liquids heretofore mentioned. The advent of the auto and the multiplicity of dry cleaning plants makes an efficient regulation a necessity. Detroit has about 35,000 autos in daily use. This, together with other uses of inflammable liquids, makes regulation and prevention an important matter, when it is understood that the monthly consumption of gasoline in Detroit is about 1,000,000 gallons more or less.

An analysis of the report of the New York fire deportment for 1913, in relation to the water used in fire extinguishment, leads to the belief that suitably designed steam boilers can be used for fire extinguishing and result in much less loss from

damage from water. The report discloses that 114,606,785 gallons of water was used on 12,959 fires with a loss of \$7,467,997.00. This gives an average loss of \$576.28 per fire and 15½ gallons of water pumped per dollar of fire loss.

Fire is supported by the oxygen content in the air. Extinguishment by cutting off air or reduction of temperature to a point when combustion ceases. The use of steam excludes air, while the use of water reduces temperature, assuming that the New York loss as stated was confined entirely to lumber of average market value the fuel value would represent, in round figures, 50,000 heat units per dollar of loss, while the water pumped per dollar of fire loss would absorb over 250,000 heat units below the boiling point. The actual excess water would be found to be greater than indicated by the figures. Much of the tabulated loss is due to water. It would appear that much loss and damage would be avoided if buildings were fitted with a system of piping to admit the introduction of steam to a room in such a manner that its expansion would force air out of the room. The condensation would rapidly dry out with little loss. The value of this method is clearly indicated in the control of fires from inflammable liquids. Why not extend the use of a good method?

THE ECONOMICS OF FIRE PREVENTION.

By FRANKLIN H. WENTWORTH, *Secretary of the National Fire Protection Association, Boston, Mass.*

The technical phases of fire prevention and extinguishment have been very well covered in Mr. Chausse's report as chairman of your committee. I would like to emphasize certain points Mr. McCabe has brought out in his paper, mainly the economic significance of the fire waste.

Mr. McCabe suggested that the American habit has been one of extreme carelessness. That is singularly true. We exceed in our fire waste, by a great many dollars per person, that of any other civilized nation in the world; we run about ten times per person in waste of created resources more than the European nations. That is due, as Mr. McCabe has suggested, to the psychology of the American. We have been born and bred in a country of apparently boundless resources, and that has been especially so in the matter of wood for building purposes, and it has seemed more logical to us to build and burn and build again, than to aim at that permanency and beauty of construction Mr. McCabe has suggested.

As to the economic waste, his suggestion that law is futile that goes too far in advance of public sentiment and education, is true. What we must do is to emphasize at every opportunity the cost of this continual drain upon the American people of about $250,000,000 a year in created resources.

The constant and enduring indifference to this loss is based upon one or two fundamental erroneous ideas that the American people possess. The average American, not alone the rank and file of the people who do not think much about anything, but even the business men of the country, believe that this

tremendous waste is paid for by the insurance companies; they are besotted with that idea. I have seen men with all the marks of intelligence reading a fire report, glancing down to see that the property was insured, and then dismissing the matter as of no importance, because the insurance company would have to pay for it.

Then the further idea, if they do not believe it is paid for by the insurance company, that it is paid for merely by the people who carry insurance policies, also is a fundamental error. If the insurance companies got their revenue from Mars or Jupiter, then we might dismiss it as something that does not concern us, but the insurance companies have no way of replenishing their treasuries except by coming to the people, not only to those who have insurance, but to any one who buys anything that comes thru the road of production, distribution and exchange. We fail to comprehend that. But when we analyze the economic effect of this loss, we see we cannot buy a hat, or a shoe, or a suit of clothes, or anything that comes thru the channel of production, distribution and exchange, without paying this fire insurance tax.

Take cotton, for example. It is insured in the sheds in the South, insured in railway transportation, in the textile factory where it is worked up into garments, in the department store, in the tailor shop, in the dry goods store, all the way along from the cotton field that cotton bears successively and cumulatively this fire insurance tax. It is obvious that when we buy a piece of cotton goods we pay that tax concealed in the price of the goods.

The big merchants and manufacturers know perfectly well that the cost of fire insurance, which is very great because of the great fire loss, is a tax upon their goods, part of the expense of their business as a going concern, and that it is shifted upon the purchaser of their goods; but the man who buys the goods does not realize it.

And that is true of all forms of indirect taxation, and that is all this is, what the French aristocrats called "The method

of getting the most feathers with the least squawking." If the people do not know they are paying it, they will accept the tax as a natural thing. If the masses could be brought to understand this tremendous economic burden they are carrying, they would be more careful.

But it is that unconscious anarchism Mr. McCabe has referred to, the throwing aside of responsibility, and not understanding the tax that makes them put ashes in wooden receptacles, and start fires in the open on windy days, and be careless with matches—we are the most careless people with matches on earth. All these careless uses of fire go back to the fact that we do not understand how it affects us individually. If we could see how it made the struggle for livelihood harder, what a tremendous point it is in our struggles for a living, we would see its importance.

For the last fifteen years the fire waste of the United States and Canada has averaged \$250,000,000 a year. Think of that tremendous sum, you men who are struggling to make municipal improvements, and with difficulty getting the money to do the necessary things, even the sanitary things that should be done immediately. What could you do with \$250,000,000 a year, absolutely wasted in this country, because all the energy turned in to replace waste must be drained from the productive processes that create revenues. That \$250,000,000 means \$3,000 an hour, \$500 a minute for every minute of the day and night; we have a continual conflagration going on in this country and Canada. What could we do with \$250,000,000 in canals, roads, municipal improvements? If we would lose \$250,000,000 a year in wheat, or corn, or cotton, or out of the United States treasury, then we would see what a tremendous economic burden the United States is carrying, but because it is assessed in this indirect way, merged with the cost of all the goods we buy, spread over the whole nation, we do not realize what we are staggering under.

We are indifferent to any ordinary fire. A \$100,000 fire in Europe shocks them. Every one wants to know how it oc-

curred, the conditions that surrounded its starting, and who was responsible for it, and all the details. Here in America, if we pick up the morning paper, and do not find two or three $100,000 fires recorded, we feel it was a dull evening. A fire that doesn't involve some holocaust, some loss of life, like the Arcady Hotel or the Melvin House fire here in Boston, that hasn't with it extremely dramatic accompaniments, we pass by as an ordinary daily event. That is also because of this unconsciousness of the burdens we are carrying.

It is clear, when we look at this matter in the true light, that we pay for each other. We in Boston are still paying for San Francisco, and for Chelsea, and Baltimore, and Salem, and tomorrow Salem and Baltimore and San Francisco and Chelsea, rising from their ashes, may pay for your city or for ours. We pay for each other, and it is clear, thru this medium of the distribution of the fire cost thru the insurance companies, that we will continue to pay for each other until we all adopt better methods of building, and then conserve what we have builded against fire.

It is obvious that the supreme burden of this tax is not from the little fire; it is from the conflagration. That is the baffling thing about this whole matter, and that is the thing that makes any approach to scientific fire underwriting impossible.

I am not an underwriter, but I have observed underwriting practices very closely for a good many years; and it is perfectly clear to me that the basis of fire insurance and the basis of life insurance are very different. They are far apart, but they may be brought together by practical engineering.

Consider, in this day of sanitation, we might say we haven't pestilence; we have very few epidemics, very few of those sicknesses which used to decimate whole populaces; life is pretty normal, and any life insurance actuary of any skill and experience can tell about how many men in a certain period of a certain age will pass away; so that life insurance is on a scientific basis. There is no reason why a life insurance com-

pany should not succeed, because it can figure out from experience exactly what the rate should be on an individual of a certain age.

But fire insurance is a gamble, and it must remain a gamble so long as an entire city may be swept out in a single night. No one knows what an adequate fire insurance rate is.

The people complain that the rates are too high. They are. Everybody knows it. But how can they be reduced except by reducing the cause of the high rates, which is the continual and promiscuous burning of created resources, which must be paid for, and we all have to contribute to rebuild Salem and San Francisco and Chelsea. And that will be so as long as we have sweeping fire losses, like Salem, $14,000,000. The rates must be maintained at a high figure, because the insurance companies do their business for profit; they are not philanthropists; they must collect enough to pay the losses and carry on their business as a going concern, and pay interest on the capital invested.

We should get the fire loss approximately on the life loss basis; that is, if thru municipal engineering we can reduce the fires to unit fires, if we can confine every fire to the building in which it originates, we can call each building a human being, and can then approximately fix the rate that is proper according to the hazard. But until we can confine these fires to the building in which they originate, it is obvious we are all at sea in the matter of rates.

What are the practical and direct engineering elements in conflagrations? It is clear that it is the unprotected lateral opening that makes the conflagration possible. I am not referring to wooden cities. Cities that are built of wood merely await the right kind of a fire on the right kind of a night. But the hearts of our cities, where the conflagration hazard is great, and where congested value is great. Fires cost more now than they used to, because of the congested value districts.

We build a so-called fireproof building, and then leave it exposed at the weakest point, with wooden window frames,

and trims, and thin window glass. Fire goes thru that building as easily as thru a wooden one. That was demonstrated in Chelsea and San Francisco and Baltimore. It ignited the window frames and window trim, broke thru, and each story of those buildings became merely a horizontal flue, full of combustible contents, thru which the conflagration passed. It is obvious our brick buildings are simply flues, full of combustible material, with drafts in the way of lateral openings, and that the conflagration hazards in the downtown districts of all our cities are due primarily to unprotected window openings. We know we can protect our window openings, either by standard shutters, which you can shut when a fire occurs. You usually can't; they are rusted open. That is another Americanism.

One of the largest department store fires we had last year due to an exposure was because the shutters were all open, and the fire got into that building and gutted it. For years that store had followed the habit of closing those shutters every Saturday night over Sunday, but this fool fire started on Thursday, and that is what destroyed the store.

We know we can protect these openings. To my mind the metal window frame with wire glass is a safer proposition than the wooden shutter. Not that it would stop the fire as well, because heat radiates thru wire glass, and where the value is very great I would recommend an inside shutter of wood, with tin covering. Then you have a combination that will stop almost any fire. But if we would use metal window frames and wire glass in the downtown districts, we would practically eliminate the conflagration hazard. I don't mean a fire won't get started and get hot enough to buckle the window frames and melt the glass and get out, but with the next building similarly protected, at each wall the fire tackles it will meet this barrier, and the fire will be held long enough so that any reasonable fire department can confine that fire, at least to the second building, if it gets out of the first by chance, due to the exceedingly high combustibles inside. If

we will merely protect the window openings of our brick, stone and concrete buildings, we will eliminate the conflagration hazard from our downtown congested districts, and that is the crux of the conflagration matter at this time, to my mind.

Other things, open spaces, wide streets, etc., are valuable, but we cannot give up too much of our cities to open spaces; we must have a place to do business, and mercantile buildings must be close together, and they must be protected from each other, and it is kindergarten work in engineering to protect them.

Desire precedes function, the scientist tells us, and we must want to do the thing before we can work it out.

Other things we must do. We are perfecting here a high pressure service system, so that we can get plenty of water down town. That is essential.

An essential thing is to instal in all of the buildings where hazards are great, automatic sprinkler systems. They stop the fires at their incipiency, and prevent large fires from getting under way. If we have those things to prevent fires occurring of any magnitude, we have the downtown sections pretty well covered.

There is another thing that goes back of this fire prevention and fire retarding system, and that is fire prevention on the part of the fire departments. That is psychological, too. The slowness and deliberateness with which we have approached the proper conception of our fire departments.

The ordinary American now thinks the function of the fire department is to extinguish fires, and has no other thought. He doesn't realize that the fire department has a tremendous force of conservation. The firemen are sent in rotation to inspect all the buildings in their districts regularly, and are given authority to keep those buildings clean, and instead of sitting around the engine house waiting for fires, these men are kept going all the time inspecting buildings. The result of that inspecting, which heretofore has been done in a casual way only by the fire chief or one of the other officers, and

which is now done by the rank and file of the fire department, is extremely fine. It not only keeps the city clean, because it is regular and continuous—the fires in the business district of Montreal have been reduced fifty per cent. since the chief there inaugurated the system of fire inspection.

Most fires are preventable; they come from rubbish, poor housekeeping, unsanitary conditions, and that inspection keeps the city clean, and it has the added value of instructing the firemen as to the physical condition of the city. When a fireman goes to a fire, think how valuable it is to know where the alleys open, where the scuttles are on the roof, where the stairways are, where the inflammable stocks of goods are stored, etc., so, when he is sent into a building, he is like a trained soldier, he knows where to put the water on the fire at its vulnerable point from the point of greatest vantage.

We are educating our fire department. And here we have had this tremendous force which we have let go to waste, that we might have been using all these years in this splendid service. The firemen like it. It gives them dignity, it gives them something to do, makes them a lot of acquaintances, they know the people of the town; it is of advantage every way, and we are just beginning to have sense enough to see that our fire departments have this great latent power, and it costs no more than to maintain them in idleness.

That is something which every American city must come to look for from its fire department. In ten years the fire preventionists in the department will leave the fire extinguishers very largely out of work. New York, up to the time of its Fire prevention Bureau, had spent $12,000 a year for inspection, and eight million dollars a year for fire extinguishment. As it increases its appropriation for fire prevention, it may very well lop off its expenditures for fire extinguishment, because it won't eventually have these big fires to fight.

We must come to individual responsibility. We can do much in the way of education; I don't think we can do much in the way of preaching. I don't think the American tempera-

ment responds to preaching. Over here in Copley Square is the Trinity Church. It used to have a celebrated preacher, in the last century, Dr. Phillips Brooks, a man of national reputation, a very scholarly man, and he used to go off to India and there study the Oriental philosophies, and when he came back to his pulpit here, his orthodox parishioners used to see these heterodox ideas creeping into his sermons. He came back from one of his trips abroad one day, and a party of his parishioners met him at the dock here, and stood by while he was being greeted in regular American style—you know how they greet you, and pull things apart, and spill your tooth powder all over your dress suit. Well, they stood around while his baggage was being inspected, and one of his parishioners said, "Well, Bishop Brooks, I suppose you have brought home a lot of new religions you have had to pay duty on?" The Bishop looked sober for a moment, and then answered, "No, I would never make that mistake. I would never bring home to the American people any religions with duties attached." I don't think we need to be preached to; I think the Bishop felt it didn't do much good to people who had that point of view.

I don't think we respond especially to the economic propaganda, although that affects the more thoughtful.

I believe the mass of the people must be restrained as they restrain them in Europe. We must fix individual responsibility, and change our attitude of mind toward the man who has a fire. In Europe he is regarded as a public offender, an offender against the common good, who has done an unneighborly thing; and we in America sympathize with the man who has the fire, although he picks our pockets thru the insurance company.

In France, if you have a fire, and it goes outside of your premises and damages your neighbor's property, you must pay your neighbor's loss. That is very beneficial and educational, and if we had it, we wouldn't have so many careless fires.

In Germany the first person who calls after you have had a

fire to offer you condolence is the policeman, and he locks you up, and you must prove that you are not responsible, or you have to pay the loss yourself, and pay the city for the use of the fire department. What would we Americans think if we got a bill from the fire department? We would think the end of the world had come. We must fix individual responsibility.

As Mr. McCabe suggested, we cannot go too far ahead of the common consciousness, because laws too far ahead of the people won't be enforced, and if we have officials that will try to enforce them, we will lose those good officials. That is the result of honest officials trying to put a law in operation ahead of the common consciousness. We all sink or swim together, and the American idea regarding the law is not as respectful as it might be. We are anarchistic in our outlook; we regard law cynically. If we can beat it by any subterfuge technically, we do so. Even the small boy has little respect for it. Over here on Washington street, in front of Siegel's old store, a woman left her baby carriage on the walk with the baby in it; there must have been something very interesting in the store, for as a rule they don't do that. The crowd going by jarred the baby carriage, and pretty soon it began to roll toward the curb, but before the front wheels got to the curb and spilled the baby out, a policeman seized the carriage, and started to look about for the mother. He couldn't find anybody who owned the baby, however, so he started to wheel it to the station, and as he passed the corner of Milk street, a little youngster standing on the corner there looked up and said, "What's the kid done?" It is that cynical attitude towards the law that most of us have. We hire our distinguished lawyers to beat the law and keep us out of jail.

We must come to respect the law, and to realize that it protects our lives, our property and our homes, and realize that we have an individual responsibility toward the collective life. That feeling that we may call the social conscience is growing in America, and such meetings as this, to work out these problems for the common good, are an evidence of it.

Your Society is a manifestation of this social consciousness, as is the work against tuberculosis, the work looking toward accident prevention in factories, city planning. Every detail of the things we do together for the common good manifests this collective will, this social consciousness, and more and more as we come to that, more and more we must make the individual see that he owes a debt, that the municipality or the government cannot do all for him, and get nothing from him in return. He must see that if the collective life owes a duty to the individual, so the individual owes a duty to the collective life, and if he refuses voluntarily to assume it, it must be placed on him legally.

And so in the matter of this fire waste; we must change our attitude of mind toward the man who has a fire, and regard him as a public offender, unless he can prove that in no wise was he responsible for that fire. And as more and more this social consciousness expresses itself, more and more we realize that life is so complex today, so interrelated, that no man can separate himself from the mass and go exactly as he pleases, carelessly and without thought of the common good. As we realize our collective interests and collective responsibilities and work it out in all departments of life, as you gentlemen are doing in these municipal problems, I believe we will begin an era of sanity, beautiful life and prosperity finer than any that the world has even yet dared to dream of. I thank you for this opportunity of meeting you this morning.

REPORT OF COMMITTEE ON PARK DEVELOPMENT AND MAINTENANCE.

George A. Parker, *Chairman, Superintendent of Parks, Hartford, Conn.*

It would not have been difficult to tabulate the cities that have parks with their acreage, expenditures and similar statements, and to have submitted that as a report of your committee on parks, and before some associations I would have done so, but the American Society of Municipal Improvements has for its membership the field workers, the men who plan and do the big things in cities' improvements, and without consulting my colleagues on the committee, I am using the few moments assigned to me in trying to place before you what I believe are of fundamental interest in park and recreation work for municipalities.

I want you to see in them something more than beautiful pictures created by landscape architects or the gardener's skill, for as important and desirable as is the beauty they create, there are other things equally as important and vital.

Cities exist not for the display of beautiful buildings and grounds, the best paved streets, a perfected water and sewer system or efficient police and fire department. Their primary purpose is to make strong and noble men and women, and I think you will admit that with all the physical improvements, there has been a failure to do so from boys and girls born and bred in cities from an ancestry born and bred in cities.

The reason is not far to seek, for living conditions in cities have entirely changed during the last two generations, and it was necessary to remodel and rebuild the cities to meet those changes, and people are at a disadvantage when rebuilding is going on. The changed conditions that I refer to are

that formerly the family produced largely what they needed in their own homes; now they produce things in large groups in factories, or to state it in another way, formerly every one worked for himself; now every one works for somebody else. None produce their own food, clothes or housing. This has given a power and importance to business and money they never had before.

At present work and food conditions are bad. There are too many pigeon-hole tenements for homes. Streets are too often used as playgrounds for children and meeting places for young folks, where they become precocious, early-ripes, worm-eaten by evil, weakened by excesses and lack of opportunity for growth and development. All this is being righted. A century ago education was believed to be the panacea. We now know it is not the cure-all. Occupation and education must work shoulder to shoulder with recreation to produce the desired result, and even these must be supplemented by other forces.

The three-legged stool upon which physical comfort rests is food, clothes and shelter. The three forces which produce them are work, study and play. The flower is social life; the fruit is wealth, health, wisdom, religion and happiness. The machinery to produce them is business, which is private, and municipal activities, which are public.

I know of no careful thought-out treatise which in a scientific and systematic way tells how to build cities or how to live in them when built. True, there are most excellent books upon special subjects like water, sewerage, police, fire, education, administration and other subjects, but the assembling of this material together like the assembling of the parts of an automobile so they will balance each other, work together and make a machine that will run, has not yet been done, for no city has yet made full grown men out of most of its boys.

I have often watched children at free play. Each child or group of children does what appeals to them at the moment, and they do many things mighty well, yet they have little

knowledge and less care as to the results upon their bodies, thoughts and emotions. A few may turn out well, but most will find themselves in a very moderate, circumscribed and restricted life. There will be all too many ne'er-do-wells. A well trained physical director changes all this. Allow him a fair opportunity, and he will give to nearly every child a well developed body filled with energy and vitality, a mind alert and strong, and a heart with true and pure emotions and not with that flabby, sick sentimentality that fills up the void of so many lives.

This illustrates city methods of the past, doing what seems best at the moment, imitating what is attractive in other cities. But the city needs the physical director the same as the child does. The evil of the child's free play is the looseness of his action and the idleness that his satanic majesty takes advantage of. The evil of the city is the looseness of its methods and thoughtlessness, and the politician takes advantage of that. Of course, each city department does its work well. The heads of them strive most earnestly for success and much scientific, extensive and practical research and knowledge prevails. The weakness consists of the want of balance and coordination between them. Team work under a general manager between the fifty or more divisions of city work is unknown, and it must come before success can be obtained.

Another factor of weakness is that each city considers itself as being a unit and to stand alone, while in fact the municipal unit should consist of all of the five hundred cities in the world of over one hundred thousand population, and that each city is but a ganglion of that whole. Surely, all the cities of one nation are as small a part of the whole as can stand alone.

It is difficult for the people of any city to realize they are only a part of a greater whole and not the whole thing themselves, yet is it not a fact, that under our modern industrial life, no city could exist unless supported or supplemented by others. Other cities are not rivals to be overreached, but coworkers to be loyal to.

The inter-dependence of cities upon each other and their mutual relations to each other and to the nation is a lesson yet to be learned. The only reliable sources of knowledge that I know of affecting life, are the statistics gathered by the United States government, by a few of the state governments, and in a lesser way by the Bureaus of Municipal Research.

Here is a great collection of material out of which can be constructed a great powerful machine, entirely capable of making a well balanced, healthy and beautiful city, one which can be as nearly sin-proof, idle-proof and poverty-proof as humanity is capable of becoming. Everything is at hand that is necessary to turn out happiness and plenty for any city that will use it. The gifts of the Creator have always been wonderfully great and good, but never have they been greater than what He now holds in His hand for people who live in cities, if they will only lift up their hands and hearts to receive them.

I have watched the movements of people in the crowded thorofares of many cities and tried to understand their activities, and study their streets and buildings, and how the different departments were doing their work, only to find it a confusion most confounding.

It seemed impossible to know anything at all clearly, and any insight I might think I had obtained was opposed by another that followed it. It was not until I had learned that by closing our eyes we could see with the mind's eye what all the people of a city or of many cities were doing at the same time, that in the still watches of the night we could hear the sounds of a nation, that I learned the lesson that one must think in a large unit if one is to know the cities of a country.

After many trials the municipal unit that seems most useful is the city of one hundred thousand population. Using this as my yard stick, as the scales to weigh what took place in cities, I found the task of getting an insight into city conditions not a difficult one, being limited by my capacity to understand.

The index system of statistics makes available and workable the great mass of statistics which have been accumulated, and it is with ease that one city is compared with another by simply changing the decimal point. The study of city conditions no longer is burdensome. It is great help to be able to work on the right side of the decimal point.

Here are some of the things each city should know about all others:

1. Their area, subdivision, topography and surrounding country.
2. Their population, number, age and sex.
3. Their earning capacity and how used.
4. Their accumulated wealth and how owned.
5. Their horizontal layers of social life, number and kind.
6. Their medular rays and their vertical movements.
7. Their food, quantity, quality and where obtained.
8. Their housing conditions, provisions for sleep and rest.
9. Their clothes, material, cost and how obtained.
10. Work and wage conditions.
11. Their provisions made for the reception and care of children that are born.
12. Preserving of records and lessons of those who die.
13. Leisure hours, how used, public, private and exploited.
14. What each department is doing, cost and results.
15. Ratios giving comparisons with other cities, the state and nation, and acres of fertile ground.
16. Taxation and valuation, and many other things.

Any one of these subjects could be discussed for hours. I mention them now to show that I feel that parks and recreation are not all there is to a city, fearing you might think I believed so from what I shall state in concluding this paper.

There will some time be an anatomist, physiologist and psychologist for a city as there are now for individuals. From their teachings will come the city architect, the city builder and the constructive social worker, and tying these together will be the school and the church, then the parks and recrea-

tion will come into their own, and perhaps may be something like the vision I now see for them.

Using an imaginary city of one hundred thousand population as my yard stick or standard, it will occupy ten thousand acres, eight hundred and fifty of which would be used for parks and playgrounds, subdivided as follows:

Three hundred and fifty acres in a large scenic country park with trees and meadows predominating, its main features being drives and walks.

One hundred acres in a scenic park largely used for golf, large picnics and their accessories.

Two hundred acres in a well developed area from fifteen to thirty acres each.

One hundred acres in small parks five to ten acres each.

One hundred acres in small squares and playgrounds of less than three acres each.

This would give about sixty of these parks and playgrounds which would supply all of the public area needed for such purposes.

There should be a limited development of these grounds of that character that is known as permanent, for not only are the needs of the people constantly changing, but people grow tired of the same thing in the same place day after day, the monotony destroying or at least lessening their usefulness. Nothing should be done in parks this year that can just as well be done next year or ten or twenty years afterwards. Of course, their locations, grading and the planting of long-life permanent trees should be done at once, the sooner the better. I know this is heresy, but there is in it a truth that makes for success.

The life of most buildings should not be planned for over twenty or thirty years.

Small tree planting from twenty or thirty years.

Shrub planting from eight to ten years.

Perennial planting from two to four years.

Flower beds, one year.

Lawns from five to ten years.

Park furniture from one to five years.

Play apparatus from one to three years.

Admitting this limitation of service, then the planning of improvements are much simplified. The nearer the parks and squares are located to the center of the city, they may become more decorative in their nature and more artificial in their conditions, and the time will come when the Boro of Manhattan in New York City will be considered the most favorable opportunity for parks and recreation without additional park land, and may be self-supporting, for it is the most congested district in the country.

The smaller parks should be bound by public streets and enclosed with a fence, set not on the property line but ten to one hundred feet inside, so as to allow an exterior and interior treatment, for parks should have an exterior and interior the same as houses and for the same reasons. The exterior treatment should be such as will please and influence those who pass in the streets the same as the exterior of houses does, and should be as correct in design and material as are the facades of buildings.

The interior of parks should be developed in accordance to the use they are put to, the same as rooms in buildings, and their decorations and furnishings should be as carefully thought out. When this is done it is easy to see that parks will be very different from what they are now.

When the development of park influences for cities comes fully into its own, it will consider the improvement of grounds around private houses, manufacturing plants and all open areas, and be prepared to supply private parties who live in the city, all the loam, compost and sod they may need, for every bushel of compost or foot of sod used on a private place adds to the scenic effect of the city as a whole, and increases the value of all property, as well as the pleasure of the people. The Park Department is the only opportunity people will have of obtaining such things in abundance at a reasonable cost.

The equipment should be abundant, sanitary and orderly, and there should always be plenty of seats, drinking water, tables, shelter and lights with such other park furniture and apparatus as the different parks may require.

While park furniture and play apparatus should always be substantial and serviceable, yet much of it need not be permanently located, but left as movable as the furniture in a house; much of it so light that a child can easily change its position. No one would think of fastening furniture to the floor or building it into the wall. Park furniture should be equally as movable. No one wants to see every article of furniture in his house exactly in the same place day after day, so people get tired of having a park fountain always at the same spot in parks.

Play apparatus should also be available for use on private places and in the homes, the same as books are loaned from the Public Library, for people do not care to use the same apparatus over and over again, any more than they want to read the same book over and over again.

The amount of time people will spend in public parks and playgrounds if conditions are desirable and attractive, I estimate to be one-fifth of their leisure time, and that the average leisure time is five hours per day per person. That would give to our typical city five hundred thousand leisure hours per day and one hundred thousand hours in the parks and playgrounds, and they should be prepared to care for that number, not all at once, for people go to parks for different purposes and at different hours, varying from the beginning of light in the morning until midnight.

Of course, the large country parks have the fewest per acre, while the attractive small parks near the center will have the most. As many as one thousand persons per acre can be cared for on the surface of the grounds, if provisions are made for them. At present only about 5 per cent. of that service is being rendered, but when New York comes to realize its park and playground possibilities, it may care for forty thousand

per acre, which can easily be done if provisions are made for them.

No preconceived idea of what people ought to do will solve the park service problem. The question is, What will they do?

Recreation, is, first, the spontaneous response to the call for action by the muscles of the body for growth that they may not atrophy; then, it is the call for action for those muscles not used in our work or study, also for the resting and restoration of muscles overworked, and the maintenance of the worked-out muscles that have been exhausted from sickness or old age.

In group work, recreation means the enabling of groups to act together as one unit leadership and the development of social relations, the co-ordination of units, and the meeting and social relations between the sexes under wholesome conditions. It also means the restful and peaceful social relations between those who, from age or weakness, are not fitted for such exertion, as well as the active relationship between those of vigor and energy.

The call for service upon our parks varies much with age, and observation leads me to divide this service for those who are:

1. Under one year old. Both sexes together.
2. One to four years old. Both sexes together.
3. Four to eight years old. Both sexes together.
4. Eight to twelve years old. Boys and girls separate.
5. Twelve to fifteen years old. Boys and girls separate.
6. Fifteen to twenty years old. In activities separate but in social life together.
7. Twenty to twenty-eight years old. In activities separate but in social life together.
8. Twenty-eight to fifty years old. Both sexes together.
9. Fifty to seventy-five years old. Socially, together.
10. Over seventy-five alone or together.

Each of these ages has different requirements, none of them difficult to provide when understood.

However much we may deny it, yet there are classes of society, for classes are made by the forces of nature and not by written documents.

I have classified them as follows:

First, as to their earning power. Those who have less than they need, those who have more than they need, and those whose earning balances with their needs.

Second, as to education. Those controlled by instinct; those who are partly under control from their training, and those who have all their faculties thoroughly active and under control.

Third, as to emotion. Those who are dull and brutal; active and humane; and those who are sensitive and responsive.

Fourth, as to race. Those who have pure blood with unchanging ancestry; mixed blood with varying ancestry; cosmopolitan, not controlled by ancestry.

There may be all kinds of mixtures of these classes, but all should be considered, if we are to provide the greatest happiness and pleasure in parks.

If I am right as to my conception of what park and playground service means, then it should be as much in touch with every home of the city as are the streets; should enter each house as does the water and become a part of each life as does education.

Up to the present time, most mixed recreation has been exploited for gain. Commercial recreation will always exist. Its special field is to furnish entertainment, while public recreation is to furnish opportunities for people who entertain themselves, a very different proposition. I do not believe it will ever be the duty of the city to entertain its citizens, but I believe it is the city's duty to provide opportunity to do so for themselves. To provide entertainment is to groom the people instead of exercise. To provide opportunity is to have exercise take the place of grooming, a very different matter.

A large part of all recreation must be private, while the very poor may depend entirely upon public opportunities, and

the very rich may care for themselves, yet the great mass of people will use much of their leisure time in rest and recreation outside of that which is commercial or public.

Much of the private recreation, on account of want of room, takes place under unwholesome and undesirable environments, and it is a part of public work to see to it that where needed, private recreation is provided with space or room, even though carried on and paid for privately.

In this connection it may be well to say that the more people out of work the greater the number of leisure hours, and the less the people earn the greater the need of public recreation.

To each park department there should be attached a bureau of information and publicity, so that those who are interested shall have at all times at their command not only all their city is doing directly, but also a detailed knowledge of all matters connected with the parks and recreation in all cities.

If I have shown even in my small way that parks and playgrounds are something more than open areas for gardners to putter in, or for little children to play in, I shall be satisfied, for I ask you to remember that whenever as good an equipment is provided to the park department to fight the evils of the city as is provided for the fire department to fight the fires, it will control the evils of a city as surely as the fire department does the fire, and, furthermore, when the provisions for the park department are as complete for its purpose as the water department is for its purpose, then the park will be as surely self-supporting, and whenever the knowledge and skill in its management equals that of the school department, it will double the efficiency of the work of the school and church and make city boys and girls more than equal to them that have the advantages of country life; make them stronger and better than the world has yet known, for in the past the progress of the world has depended upon people from the country. In the future it will depend upon those from the city.

DISCUSSION.

Mr. Parker: In other departments of city work you have your work organized, but in the park department we have hardly begun the work. There were no municipal parks in this country prior to 1853, although we have had gardens from the time of Adam and Eve. In 1853 we made our first park, a scenic park. Then in 1875 came plans for park systems. In 1893 the boulevard parkway and reservation system were brought forth by Charles Eliot. In 1898 began the playground system; in 1901 or 1902 began the social settlement idea, which has been carried so far forward in Chicago, and in 1905 and 1906 began the city planning. Another step just about to be taken in the park work is the recreation part of the park.

The park work at present is in the same stage of development as was the old town pump as compared with the present water systems. That was the old idea of Palestine, that everybody should come to the well. When the park work comes into its own, it will be as intimately connected with the household as the streets are, and will enter every home as much as the water does, and when it is well understood it will double the value of educational and church work. When we have as good equipment for fighting the evils of the city as the fire department has for fighting fires, we will take care of those evils as well as the fire department does the fires, and when it is completed we will make a sin-proof and an idle-proof city. The parks can do that, and no other department of the city can. I thank you.

SMALL PARKS FOR SOUTHERN CITIES.

By C. D. POLLOCK, *Consulting Engineer, New York City.*

A great deal has been said and written concerning the sanitation and health of cities and towns, but usually this has been from the standpoint of cleanliness alone. Sewers have been constructed to carry away the wastes from households, manufacturing plants, etc. Then the rivers have been improved by means of the purification or semi-purification of the sewage before it is deposited in these streams; streets have been paved and then cleaned at frequent intervals; water supplies have been constructed and the watersheds patrolled, to prevent pollution; better methods have been devised for collecting and disposing of garbage, and other refuse; and so on down the line of municipal activities, but it is only in recent years that cities have been realizing that their activities should not cease here.

It is now considered necessary that cities should see that their citizens get light and air, and proper places for recreation.

Building codes have been adopted, providing for the construction of tenements along correct lines, but this is not all, it is necessary in addition that parks and play-grounds be provided.

Each year city officials realize more and more the necessity for parks. Where formerly they were considered show spots, and ornamental luxuries, they have now proved themselves to be absolute necessities, especially in the larger and more congested cities.

It is the purpose of the writer in this short paper to suggest how many of our cities and towns, and more especially some of the smaller cities in the South and Southwest por-

tions of our country, can construct parks at small expense and add to the beauty, comfort and health of these cities.

Most Southern cities have one, and often several, large plazas, or squares. It is expensive to pave these great expanses with good pavements, and consequently they are usually hot, dusty, wastes in the Summer season and mud holes that are nearly impassable in the rainy Winter weather. These spots are wholly unnecessary for the purpose of accommodating the traffic. They are in general barren of trees or shrubs, and the hot Summer's sun beats down mercilessly upon the unfortunate pedestrians who are obliged to cross them during the hot portion of the day.

These barren wastes may be made into attractive spots, with shade trees and shrubs planted judiciously to offer protection from the hot sun, for the passersby, and a reasonable width roadway with a good pavement can be constructed around such park or parks at a moderate cost, whereas the cost to pave the whole square with a good pavement would have been prohibitive. Care should be taken in the selection of the trees in order that those trees giving a maximum amount of shade may be obtained, and these should be trimmed so as to permit of the free passage of air underneath. Hardy grass, such as the Bermuda grass, can be made to grow with a moderate amount of watering, and this will add to the beauty of the little park and it will also be much cooler than too much cement walk or other pavement.

In cases where cities have attempted to pave these squares, the cost has been heavy, and the results not very satisfactory. Block pavements tend to buckle, and bituminous pavements do not get sufficient traffic in these great areas to keep the surface properly compressed for them to prove durable.

In many cases these same cities have laid out very wide residence streets. Here again there is afforded an ideal chance to add a parking. By constructing a narrow roadway of from twenty to twenty-five feet, a good pavement is made possible as far as cost is concerned, and a wide grass plot may be

placed between the curb and the walk, where shade trees and small shrubbery should be planted. This will add very materially to the looks and comfort of the street.

Of course these streets may be treated in another manner, that of constructing two narrow roadways and placing the parking in the middle, but this locates the park where it will not be as useful in affording shade for the pedestrians, and unless the property owners have a strong organization to care for the parking, or the city's park department takes charge of it, this method is less satisfactory, for some will look after the portion in front of their premises and others will not do so. When the parking is on the sides, the occupants of the houses are more likely to care for its condition as it really forms part of their own lawns. This applies especially to rented property. Where the parking is in the middle of the street it is very hard to interest renters or simply tenants in its upkeep.

Still another case is that where streets intersect at an acute angle. Here there is an opportunity for a small park of a triangular shape. At these points the plots are often too narrow for a building to be erected on them and are thrown into the roadway or the sidewalk. By using care in arranging the trees and shrubs, these can be so placed that an unobstructed view can be had, so that traffic may proceed without danger from collisions, and yet pedestrians will be afforded another resting and breathing space and protection from the sun.

These all add greatly to the beauty and attractiveness of communities, as well as to their health and their comfort. These parks and parkings are moreover cheaper than paving unnecessary widths of roadways.

DISCUSSION.

MR. FOLWELL: Do you find that in the southern cities it is more difficult to maintain a good grass plot than in the northern cities, especially on the east coast, because of the sandy soils?

Mr. Pollock: Yes, it is difficult to maintain grass there. The farther west you go, the more you get into the clay, and the better the grass. This Bermuda grass is very hardy. It will burn out and be apparently dead and the first shower that comes, or a good sprinkling, will revive it so that in a day's time it is green again.

Mr. Hodgdon: The author seems to recommend building the sidewalk near the property line, and having a parkway between the sidewalk and the curb. I see no objection to putting the sidewalk up against the curb, and having a wide parkway between the walk and the property line. You can then put the shade trees near the property line, and you don't have the trouble of having your sidewalks torn up by the roots of the trees. Also, where you find ground that is rough and hilly, where the slope across the street is considerable, you can park that on a slope from the sidewalk to the property line, and save the expense of cutting down, which you must otherwise do, and you can save putting in unsightly retaining walls along the property lines. I think it is a more pleasing effect, and costs less money to do it.

Mr. Pollock: As to the location of the walk, that is a matter that could best be left to the property owners. In a northern city there is an advantage in having the walk next to the curb in connection with shoveling snow; it makes it easier to get the snow into the street. In the southern cities, of course that doesn't figure. In the southern cities also you often find very wide streets, 80 and 100 feet in width, where a roadway of 24 feet is abundant for the traffic, and there you can get considerable parkway so that you can plant trees without much danger of the roots raising the sidewalk.

Mr. Corson: Is the parking of those streets done by the municipality, or is it done by the property owner?

Mr. Pollock: It depends on the city to a large extent. In one case, in cutting out the roadway, we got enough material to do the filling on the sides, and the property owners then

took enough pride in it to see that grass was put on there. We leveled it off, and it gave the contractor a short haul.

MR. CORSON: I understood you to say that the underlying strata of clay held the moisture for the plants as well as the grass.

MR. POLLOCK: Yes. That is in a city where you have clay. Of course, in Florida and along the Gulf that might not be true.

MR. SANDS: This matter of parking roadways is vital with us, and I have taken the ground that the sidewalk should be close to the property line where topographic conditions will permit. By having the sidewalk back from the curb, the pedestrians avoid the dust and dirt and fumes from the automobiles.

REPORT OF SPECIAL COMMITTEE ON SIDEWALKS.

ANDREW LENDERINK, *Chairman, City Engineer, Kalamazoo, Mich.*

Your Special Committee on Sidewalks begs to submit the following report for your consideration and discussion:

It is based upon the suggestions given in the paper by A. Prescott Folwell, at the Wilmington Convention, on "Control of Sidewalk Construction and Maintenance."

Your committee in this report has not endeavored to change your specifications for sidewalk construction, as found in the Nineteenth Annual Proceedings of this Society, and the Fourth Annual Proceedings of the Association for Standardizing Paving Specifications, but to confine its report to the subject of regulations.

The question of control of construction and maintenance must be regulated by the city charter and through some form of an ordinance. All of us realize that a poor ordinance is worse than none at all, and that great care should be taken in drafting one, so that it covers all the necessary points, and still does not impose a lot of petty detail and annoyance upon the city officials. Mr. Folwell, in his paper, classifies the methods employed by the several cities under four heads: First, those in which the city does the entire work; second, those in which the matter is left entirely to the property owner, either with or without inspection; third, those in which the contractor is placed under bond; fourth, those in which the property owner is required to construct sidewalks when ordered, make his own contract for the construction, which construction the City Engineer or a similar official is supposed to carefully oversee, and is to a certain extent responsible for.

He calls attention to the fact that in a large number of cities there is little if any regulation in the matter of sidewalk

construction, and suggests that the city should control the construction of walks under the same kind of regulations and processes as it does street paving.

The chairman mailed letters to a number of city engineers in different parts of the country, requesting them to please forward copies of their sidewalk ordinances, and to state whether the walks in their city were built by the city or private contract; under whose supervision; whether they were built in front of single lots or whole blocks between intersecting streets. Also to send any suggestions that they might have regarding the regulations of construction.

Nearly all the replies stated that walks were built both by the city and by private contract under the supervision of the City Engineer. Indianapolis, Ind., and Davenport, Iowa, replied that walks were built the whole block at one time including the walks at the intersections. Madison, Wis., replied that although they were ordered in by the block, the order was effective only against those owners who had not constructed walks. Others replied that the city filled in the gaps, or as the council ordered, and a number replied in front of single lots.

A number of the cities sent copies of their ordinances, forms of contract, permits, inspection blanks and rules governing construction. Denver, Colo., and Cleveland, Ohio, divide the city into sections and award separate contracts for each section.

At Grand Rapids, Mich., the city council has the power to order the improvement of any unimproved street, at which time the sidewalks are built along with the other street work, and the cost of the whole is assessed as one improvement.

At Kalamazoo, Mich., there is an ordinance in force that requires the owners of any new subdivision or plat that they wish accepted by the city, to first submit profiles showing the proposed grades for the streets to the City Engineer, for approval, after which the streets must be graded according to the approved profile, the sidewalks built on all the streets under the city specifications and the roadway surfaced with a

suitable road material. The ordinance also governs the widths of streets.

In all the cities that mailed copies of their ordinances to the committee, the City Council or Board of Public Works have the power to order sidewalks constructed where they may deem them necessary. The regulations and control of construction are under the Board of Public Works, or the engineering department of the city.

Mr. Folwell's suggestion could be followed for the manner of construction of walks in new sections of the city or parts where very few walks have been built. By the addition of a clause which would require that when new sidewalks are constructed they shall be built the full distance of the block between intersecting streets, except in cases where there are gaps of shorter spaces between existing walks.

The regulations for sidewalk construction must not only cover the construction of new walks but renewals and repairs as well. The material received by the committee has been compiled into one set of rules and regulations as a tentative form so that the sections that best fit the requirements of a city may be chosen.

These rules do not provide for the employment of a regular inspector for each piece of construction. But the committee would recommend that such an official or officials be employed whenever the amount of construction will warrant. The rules require that every person, firm or corporation doing work of this nature furnish the city a bond of a stated sum which acts as a guarantee that said builder will construct the walk in accordance with the city specifications without necessitating a paid inspector upon small pieces of work.

SIDEWALK.

Rules and Regulations.

Preliminary—The following Rules and Regulations have been prepared for the information and guidance of all sidewalk builders and others doing work of this nature under the super-

vision of the Board of Public Works. These rules and regulations cover the various provisions in the city charter governing the construction and maintenance of sidewalks and the ordinances passed by the city council.

Bond and License—(1) Every person, persons, firm, corporation or association desiring to engage in the construction, repairing or rebuilding of sidewalks on any public street, avenue, lane or alley in the city of ...., shall, each year, before receiving any permit to do such work, apply in writing for a sidewalk builder's license and execute a bond in the penal sum of two thousand dollars ($2,000.00), signed by two or more sureties, unless the builder is the actual owner of the lot or lots adjoining said sidewalks, in which case the amount of the bond shall be five hundred dollars ($500.00), said bonds to be approved and filed with a copy of the license with the Board of Public Works.

Purpose of Bond—(2) The bonds shall be conditioned to protect the city harmless from all loss and damage arising from the failure or neglect of such person, persons, firm, corporation or association to fully comply with the ordinances of the city relative to safety, and for all damages or loss sustained by the city primarily or incidently by reason of such work or materials used in the same not being properly and carefully guarded and protected during the full progress of the construction, laying or rebuilding of such walk; and that the builder will keep the walk in good and perfect repair for the period of two (2) years after its completion. The City Engineer's decision that the walk needs repairs shall be final.

Permit—(3) Before commencing the construction of any sidewalk on any of the public streets, avenues, lanes or alleys, all contractors or builders shall obtain a permit from the City Engineer for which he shall pay the sum of two cents per lineal foot of sidewalk; said permit shall be in writing, and shall state the name of the owner of the property, the street upon which, and the lot, lots or parcels of ground in front of which the walk is to be built. The permit shall include the

right to use ten (10) feet of the width of the street, but no permit shall extend more than fifteen (15) days from the time the grading for such sidewalk shall have been completed.

Grade, Etc.—(4) No walk shall be constructed, laid or rebuilt, without the party or parties doing the work having first obtained from the City Engineer the proper grade, width and alignment for such walk. Said grade, width and alignment shall be furnished only to property owners wishing to do the work, and holders of sidewalk builder's license, on receipt of a written application giving the necessary information.

Stakes—(5) Stakes will be set by the Engineer to define the line of one edge of the walk, and the grade marks at said line. The transverse slope of the walk will be three-eighths inch (3/8) per foot, unless other directions are given by the Engineer. The marks given by the Engineer shall be carefully examined the full length of the line staked, and if there is any question as to a clear understanding of the line or grade as there given, an explanation shall be secured before commencing work. The person or firm to whom the permit is issued will be held responsible for any deviation from the lines and grades given.

Obstruction of Gutters—(6) The contractor or builder shall not obstruct the gutter of any street contiguous to his work, nor prevent in any manner the flow of water in same, but shall use all proper and necessary means to permit the free passage of surface water along the gutter. Rubbish and material must positively be removed within twenty-four (24) working hours after the completion of work, and in cases where more than one (1) week's time is required to complete the work, rubbish must be cleaned up as the work proceeds.

Driveways, Permit For—(7) Any person, persons, firm or corporation desiring to construct a private driveway from the gutter to street line, shall secure a permit from the City Engineer to execute such work, which shall be in accordance with the plans adopted by the Board of Public Works, and the specifications hereinafter given. Bonds shall be furnished as herein provided for sidewalk construction.

Areaways, Permit For— (8) No person, persons, firm or corporation shall excavate, construct or build any areaway or basement under any sidewalk, in any street, avenue, lane or alley without first securing a permit from the City Engineer. Said person or persons shall, at the time of making application for such permit, furnish the City Engineer with plans and specifications for such walls, walks, etc., which shall be approved by the Board of Public Works before the permit is issued.

Plans—(a) The plans shall show sectional elevations and such other data as is required to properly investigate the design.

Such areaway or basement shall not extend into or under any street, avenue, lane or alley, farther than to the inside of the curb line of such street, avenue, lane or alley.

Bonds shall be furnished as herein provided for sidewalk construction.

Reservation to City of Right to Use Space—(b) In granting permission to excavate, construct or build such areaway or basement, the city does not relinquish any right it has or may have to use that portion included in such area or basement, for any purpose for which it might have used the same if such permission had not been granted.

Foundations for Areaways—(c) Walks built over areaways or basements shall be supported on a masonry or steel substructure of sufficient strength to support, together with the dead load, a uniformly distributed live load of three hundred (300) pounds per square foot.

Walls shall be built of stone, brick or concrete to retain the roadway of the street or the side, end or party walls of such building. Said walls to be not less than two (2) feet thick or the equivalent in reinforced concrete or buttresses.

Manhole Castings, Etc.—(d) Openings in the roof of any areaway or basement for the admission of coal, light or freight, or for manholes, or any other purpose, shall be covered with glass set in iron frames or with iron covers having a rough surface

so constructed as to prevent the same from becoming slippery and dangerous to public travel. The frame shall be rabbeted into or made flush with the sidewalk, so that the cover does not project above the surface of the walk.

When any such cover is placed in any sidewalk, it shall be placed as near as practicable to the outside line of the curb, and must be closed at all times except when necessary for the usual and proper use thereof. When metal doors are used as covers for openings they shall open crosswise of the walk so as to act as a protection or guard to public travel. Vault light frames shall in general be placed adjacent to the building line.

Entrances, Cellarways and Openings.—(8) No entrances, cellarways, or openings for the purpose of access or for the admission of light shall be constructed and no steps or other projections shall be made on the walk between the building and the outer line of the walk without the permission of the common council.

Retaining Walls—(10) No permits shall be issued where retaining walls are to be constructed back of sidewalks until plans for such walls have been submitted to the Board of Public Works for approval.

In general these walls shall be of ample strength to retain the earth, and the top of such walls shall be parallel with the sidewalk grade and shall be built with the face of the wall on the street line.

Trees—(11) Trees shall not be injured, cut down or otherwise disturbed, except by order of the Engineer. Small roots within the foundation shall be cut away, and large roots covered with earthenware half pipes. Walks shall be fitted to trees as directed.

Water Ways—(12) No depression or ditches or channels shall be permitted in any walks for the purpose of conveying water from down spouts on adjacent property across said walks. All water ways which may be needed shall consist either of cast iron pipe laid through and under said walk through curb, or of rectangular construction with an accept-

able corrugated iron or grated cover, which shall lie flush and smooth with the adjacent walk. No down spouts from buildings shall be permitted to discharge on to or across said walks, and in any case where walks are constructed where such conditions exist, a provision shall be made when constructing said walk to carry the water from said down spouts or from any drain pipes or tile from adjacent lots underneath said walk in the manner hereinbefore provided. Any water way, drain, or down spout which in the opinion of the Board of Public Works is discharging water across or upon a sidewalk which may become a hazard or a menace to the traveling public shall be condemned by the Board of Public Works, and proper provision immediately made to carry said discharged water below the surface of the walk as hereinbefore provided.

Debris on Walk—(13) Where the elevation or topography of any lot or parcel of land abutting upon a sidewalk is such in relation to the sidewalk that earth, stone, sand or gravel slide, fall, or are carried upon such sidewalk by force of gravity or by action of water, the owner or person in charge or control of such lot or parcel of land shall within twenty-four (24) hours after the depositing of such matter upon the sidewalk remove the same or cause to be removed. If by reason of the elevation or topography of such lot or parcel of land a recurrence of such obstruction or nuisance upon the sidewalk is probable or reasonably to be anticipated the owner or person in charge or control of such lot or parcel of land shall construct upon his land suitable retaining wall or other device as will effectually prevent such recurrence.

Materials, Specifications—(14) For materials and specifications for construction, see pages 286-291 of the Nineteenth Annual Proceedings of this Society, and on pages 146-149 of the Fourth Annual Proceedings of the Association for Standardizing Paving Specifications.

Walks Ordered Built—(15) That the Board of Public Works may by resolution passed, at any meeting of the Board require the building of any new sidewalk upon the petition of five (5)

or more taxpayers residing in the ward in which said sidewalk is proposed to be laid, in which resolution shall be specified the kind, the width, and the length of the sidewalk to be built and also designate the time in which the same shall be built, which shall not be later than thirty (30) days after the passage of such resolution. Immediately upon the passage of the resolution by the Board of Public Works ordering sidewalk to be built, it shall be made the duty of the City Clerk to cause the publication of such resolution, also the publication of a notice stating the name of streets upon which sidewalks are to be constructed, which resolution and notice shall be published in the official city paper as provided by law.

It shall be the duty of the owners of any property abutting upon a sidewalk ordered to be built, to build said sidewalk in accordance with the publication therefor. If said sidewalk is not constructed within thirty (30) days, unless a longer time is granted by the Board of Public Works, then it shall be and is hereby made the duty of the Board to proceed to build said sidewalk. A detailed estimate therefor shall be made under oath of the City Engineer and submitted to the Board.

Sealed proposals for the construction of said sidewalks shall be invited by an advertisement published by the City Clerk, in the official city paper, at least three (3) consecutive days, and the Board of Public Works shall let the work by contract to the lowest responsible bidder, if said bid does not exceed the estimate.

Right to Condemn Defective Walk—(16) The Board of Public Works may at any time by resolution condemn any portion of any sidewalk, whenever in its judgment, it shall be deemed necessary and provide for the construction of a new sidewalk in accordance with the provisions of this ordinance.

All public sidewalks, or repairs to same built under the order of the Board of Public Works, except intersections of streets, sidewalks in front of public property and in the public parks of the city, shall be assessed against the private property abutting on said sidewalk, as provided by law.

Damages Because of Injury Received From Defective Walk—(17) In event that the city shall be compelled to pay any judgment for damages because of any personal injuries received on any defective sidewalk within the limits of the city, the city may recover the amount so paid from the owner, or owners, of said lot or premises adjacent to such defective sidewalk; provided, however, that such owner, or owners, are notified of the commencement of the proceedings in which such judgment shall be secured against the city and given an opportunity to defend the same; and provided, also, that such owner, or owners, of such lot or premises shall have been notified of such defects before such injuries shall have been received, and in case such owner or owners cannot be found within the city, service of such notice upon the occupant of such lot, or premises, shall be sufficient notice to such owner or owners. And in all cases brought against the city to recover damages on account of injuries sustained in consequence of defects in any of the sidewalks of said city, the city may, upon application to the court in which such suit is brought, and after notice thereof to the owner or occupant of the lot, or premises, adjacent to the sidewalks where such injury is alleged to have occurred, be permitted, in the discretion of the court, to implead such owner of such lot or premises, as a party defendant in said cause, and in case a judgment shall be rendered as against the city, a further judgment may, upon motion, be entered as against such owner of said lot, or premises, so made a party defendant for the full amount of the damages and costs for which the plaintiff recovered judgment, and the city shall be entitled to execution therefor.

Removal of Snow and Rubbish—(18) No owner or occupant of any lot or building within the corporate limits of the city, shall permit or suffer to remain upon the sidewalk adjacent to said lot or building, or in any alley adjacent thereto, any snow, ice, or rubbish of any kind.

Failure to Remove Rubbish—(19) In case any person shall neglect or refuse to remove any obstruction, encroachment,

merchandise, snow, ice, or rubbish from the walk in front of the lot or lots owned by him, or from the alley or alleys adjacent thereto, after having been notified so to do by the direction of the Chief of Police, or other authorized officer, the city may, if it shall deem it for the public interest, cause the same to be removed at once, and the expense of such removal may be recovered against the person so neglecting or refusing to remove the same, in an action of assumpsit, in the name of the city, with costs of suit, in addition to any fine to which such person may be liable hereunder.

Removal of Barricade—(20) No person shall remove any barricade erected in front of or about any new or defective sidewalk, or in any way interfere with, change or destroy such barricade, until such sidewalk is built, repaired or rebuilt, under penalty, as stated under section twenty-one (21).

Penalty—(21) Any violation of the provision of the ordinances under which these rules and regulations are formulated, shall subject the person or persons violating the same to punishment by a fine of not less than five dollars ($5.00) nor more than one hundred dollars ($100.00), and costs of prosecution, or by imprisonment for a period of not less than five (5) days, nor more than ninety (90) days, the Board of Public Work is authorized to revoke the license of any contractor having a sidewalk builder's license.

DISCUSSION.

MR. FOLWELL: I was glad to have it again brought to our attention by the Mayor that Boston is doing, and I believe for years has done, what I put forward as a suggestion in the paper referred to last year, namely, that the City of Boston constructs the sidewalks itself. It doesn't order the property owner to construct the sidewalks, and doesn't send an inspector around to see that they are constructed right, but the city itself constructs the sidewalk as naturally as it would a roadway. I do not see why that is not the proper method, why the sidewalk is not as much a piece of public property as the

roadway, and why it should not be built and maintained under the same conditions.

THE SECRETARY: Since the adoption of its charter in 1891, Indianapolis has considered its sidewalks in the same category as the pavements and the city has constructed them all in the same way, and assessed the benefit on the property in the same way they would a street pavement. And since the adoption of the general charter for cities in Indiana, which is based on the Indianapolis charter and was passed some ten or twelve years ago, that has been true of all the cities of the state of Indiana.

THE PRESIDENT: Grand Rapids does the same in its new construction, but on old work we take a bond from sidewalk contractors. I don't know whether it would be possible for the city to do all the repair work or not. We have a marshal who notifies the people to construct their walks under council's direction, and if not built within twenty days, the city builds them and charges the cost to the property owner.

MR. NORTON: There were two small matters I want to mention. One was in connection with the use of the iron covers or doors in the walk. I believe we should require a flush hinge. I notice in some cities, including our own, they use a hinge which projects above the surface of the walk, and this hinge is entirely unnecessary; it can be made flush. Second, as to the carrying of water channels across the walk. It seems that the day has passed, especially in the larger cities, and I do not see why not in the smaller ones also, when that should be allowed. The ordinances in Buffalo require that the rain water leaders shall be connected with the sewer. Why should we make provision for carrying the water across the sidewalk? I think that is an ancient provision, and that it is time it is abolished. One other thing, in regard to the legal questions. Those requirements are special and are not applicable to all of the states. In the state of New York one of two negligent parties cannot recover against the other, and if

the city has recovery made against it for negligence in maintaining or repairing the sidewalk, it cannot recover against the owner of the property. Action can be brought against either, but one negligent party cannot recover against another negligent party.

MR. SHERRERD: I would like to ask Mr. Norton what he does with his rain water in streets where there is no combined system of sewerage, or no storm water sewerage; in other words, in cities that have separate systems and do not lay storm sewers through all their streets. It is a serious problem to know just what should be done with the leader water, where you don't allow it to go into your sewers. We found it was necessary to allow the leaders to be carried under the sidewalks in certain sections where there are only sanitary sewers, and we have gone to the extent that they be allowed to go through the curb. I think it advisable that the city authorities should regulate it in some way so that it may be uniform.

MR. NORTON: I was speaking from experience with the combined system alone. In a closely built locality it is difficult to take care of all the rain water which falls, not alone on the street, but upon the closely built area, and would warrant the construction of some surface drainage sewers in the northern cities where the ice and snow conditions are so severe.

MR. SANDS of Houston, Texas: We have an engineering department of some fifty employees, and I am safe in saying that our sidewalks cause half of our trouble. Our difficulties are not from an engineering standpoint, but from a legal standpoint. We find cases where sidewalk grades have been given in past years and sidewalks have been put down; then because of improvement in the street we find it necessary to change the grade, and the citizens strenuously object to paying again for sidewalks. We have what is known as the Homestead Law, which provides that if a person has a piece of property as a homestead, he cannot be assessed for special

improvements; so if the city orders a walk changed, and the individual won't change it, it is a question whether we can change the walk and make the individual pay for it. We also find the necessity for a very liberal expansion joint near our curb lines. We have many instances where the sidewalks have pushed the curbs out, and we require a joint of one inch filled with A. C., or two inches filled with felt and asphalt. Where the joints are left open, they fill with sand and other material, and it destroys the curb. The report states that certain legal proceedings shall take place if certain damage occurs. I would ask if that has been scrutinized by proper legal authorities so that we may know these things can be enforced?

MR. LENDERINK: All the clauses in that report are taken from different ordinances the committee has received in force in different cities. Each city would of course have to have a ruling by its own legal department, but they are all legal in certain sections of the country.

THE PRESIDENT: If they are not legal, we should work to have them made so, so they might be adopted as standard.

MR. CARPENTER: We have had some trouble as to the grade or pitch of the walk. The committee recommend a pitch of 3/8-inch to the foot, unless permission to the contrary is given by the engineer. It would seem that 3/8-inch to the foot is more than should be allowed if less can be obtained. The level walk is the ideal walk, and with a smooth surface we should have just as little pitch as will take the water to the curb. It would seem that 1/4-inch is all that is necessary to allow for drainage, and that a walk of that pitch is better. I believe we should decide upon what shall be the maximum pitch under all conditions; that is, conditions vary, as, for instance, at a store entrance, where there may be two steps, the engineer in practice would be strengthened by the backing of an opinion by a Society like this, and I think we should fix a maximum pitch. We have decided we will not put in a granolithic walk to exceed 1/2-inch pitch across the walk, and

have required reconstructions to fit that pitch. As to the difficulty with changing grade, it is of course desirable that the citizen have the benefit of advice of the city authorities. Oftentimes that advice cannot be given as an absolute thing in connection with a street or sidewalk. It is our practice to furnish the citizens those grades upon his application, but upon his signing a blank recognizing that the grade is approximate, and that it may be changed, and holding the city harmless because of any future change. That applies with us to streets, but might be made applicable to sidewalks also.

MR. BABCOCK: Under materials, reference is made to the Nineteenth Annual Proceedings of this Society and the Fourth of the Association for Standardizing Paving Specifications. I believe it might be stated that they are printed in this copy of the Proceedings, for the committee in its report this year has made no change in the specifications. As to grade, I believe our report recommends that the maximum pitch of the sidewalk be not more than 3/8-inch.

MR. HALLOCK: There would undoubtedly arise occasions, say at the intersections of streets, where it would be impossible to make even the maximum pitch apply, and I think this is one of the cases where the engineer in charge must be to a certain extent arbitrary in his decisions and insist upon it. He must adopt a grade for these individual cases which in his judgment is approximate for the conditions. Many engineers are too much influenced by existing conditions. Rather than do some slight harm to a property, which may be old and may stay there but a couple of years longer, they try to take care of it, and make a mistake, and perhaps in some cases hurt their reputations. Although we have an ordinance providing the maximum grade, there are cases coming up continually where that maximum cannot be adhered to, and the engineer must use his own judgment. Our maximum grade, I believe, is one-half inch.

CONCRETE HIGHWAYS.

By GEO. W. MYERS, *Road Engineer, A. A. P. C. Mfrs., Formerly Chief Engineer Paving, Ft. Smith, Ark.*

At our meeting in Dallas two years ago, we discussed at length the subject of concrete pavements, considering not only their many advantages but alleged defects. Our knowledge at that time was more or less superficial. It is my purpose on this occasion to present certain observations based upon recently acquired personal experience in the construction of concrete roads.

That modern traffic demands better and heavier types of construction than have been used in the past is universally conceded. In brief, it is quite as essential to adopt permanent improvements of this character for public highways as for railways. Undoubtedly the consensus of opinion in engineering circles is that the waterbound macadam and gravel roads are obsolete, a conclusion based upon practical experience with these types of roads, it having been demonstrated that they cannot withstand fast moving automobile traffic, which will represent the preponderance of traffic of the future, if it has not already reached that status. The slipping and grinding action of the driving wheels of the automobile loosens the binding dust, which is subsequently dispersed by winds and rain, to be followed by the rapid disintegration of the road. It is imperative that we find a remedy for this condition, and my recent experience in the construction of concrete roads has led to the firm conviction that highways of this type, when properly constructed in one or two courses, will solve the problem. This conclusion is based upon the reasonable first cost and extremely low maintenance cost of concrete roads, as well as their general efficiency under every type of traffic.

Comparative Cost Data on Concrete and Macadam Roads.

First Cost	CONCRETE ROADS 500 miles to be built during five years 100 miles per year at $13,000 per mile $1,300,000 per year			MACADAM ROADS 500 miles to be built during five years 100 miles per year at $10,000 per mile $1,000,000 per year		
Accruing costs first year	Interest, including extinguishment	4.47%	$58,110	Interest, including extinguishment	4.47%	$44,700
	No maintenance			No maintenance		
Second year	Interest		116,220	Interest		89,400
Third year	Interest	$174,330		Interest	$134,100	
	Maintenance	2,500		Maintenance	100,000	
			176,830			234,100
Fourth year	Interest	$232,440		Interest	$178,800	
	Maintenance	5,000		Maintenance	200,000	
			237,440			378,800
Fifth year	Interest	$290,550		Interest	$223,500	
	Maintenance	7,500		Maintenance	300,000	
			298,050			523,500
Sixth year	Interest	$290,550		Interest	$223,500	
	Maintenance	10,000		Maintenance	400,000	
			300,550			623,500
Seventh year	Interest	$290,550		Interest	$223,500	
	Maintenance	12,500		Maintenance	500,000	
			303,050			723,500
Eight to twenty years	Interest for 13 years	$3,777,150		Interest for 13 years	$2,905,500	
	Maintenance for 13 years	162,500		Maintenance for 13 years	6,500,000	
			3,939,650			9,405,500
	Total		$5,429,900	Total		$12,023,000
	Total cost per year		271,495	Total cost per year		601,150
	Cost per mile per year		542.99	Cost per mile per year		1,202.30

Note.—The concluding figures giving the cost per mile per year of the respective types of roads include both interest and maintenance. There is a vast difference, however, when maintenance costs alone are considered. By referring to the seventh year it will be seen that the maintenance charge for concrete is only $12,500 as against $500,000 for macadam.

Naturally, the query arises: "Why is there true economy in first-class concrete roads?" This may be answered in part by stating that official and entirely reliable records show that the average cost of building a one-course concrete road is $1.24 per square yard, and for a two-course concrete road $1.40 per square yard, and that maintenance, which is just as important, if not more important, than initial cost, is from one-quarter to one-half cent per square yard per year. This is the record in spite of the tremendous increase in traffic brought about by improved roads, the figures covering actual cost on roads throughout the United States. From a carefully compiled table of comparative cost data on concrete and macadam roads, I take the table on the preceding page.

To show that the comparative figures given in the table have not been strained in favor of concrete roads it may be stated that in estimating the maintenance charge for macadam roads, an average of the cost in the states of New York, Pennsylvania and New Jersey was taken. For the concrete road the average cost of maintenance on a Bellefontaine, Ohio, road was taken for a period of 18 years. The interest charges include extinguishment fund on bonds maturing in 50 years, although the table is carried only to the 20-year point.

As a further example I recall a street intersection laid more than 11 years ago by City Engineer Fred R. Charles of Richmond, Ind., which is still in very serviceable condition and has cost little or nothing for maintenance. In later work both methods and designs have been improved and without doubt the 15 or 18 millions of square yards to be finished this season in the United States and Canada will give excellent returns on the investment.

Before taking up the concrete features of road construction it is important to consider the foundation. The shape of the subgrade has received a great deal of attention of late and the present prevailing practice is to make it practically flat, with a recommended tendency toward a "dished" or concave surface, thereby resulting in thicker concrete where traffic and

tensile stresses are greatest. The compacting and drainage of the subgrade are of the utmost importance in a concrete road as well as in any other type of road. The rolling should be done thoroughly with a roller sufficiently heavy to compact the materials to a depth of 6 or 8 inches. The weight of the roller and number of times the road should be rolled depend upon the material, bearing in mind the fact that better results can be obtained by using a lighter roller many times than by using a heavy roller only once or twice. It is also important to have the sub-base free from ruts and depressions, and in a saturated condition before placing the concrete upon it.

If the subsoil is not self-draining in nature, subdrains should be installed. These should be of broken stone, gravel or farm drain tile placed on one or, in extreme cases, both sides of the roadway, with transverse lines about every 50 feet, and from 2 to 3 feet deep, with good and sufficient outlet. As a government engineer has said: "The first consideration is drainage, the second consideration is drainage and the third consideration is drainage." In other words, the matter of proper drainage cannot be too strongly emphasized.

In constructing a concrete road over an old macadam road, especially where the new road is to be wider than the old road, it is considered the best practice to first scarify, spread and roll the old roadbed. This is to insure a sub-base of an even bearing quality. Disastrous results have followed neglect of this important matter.

Upon this properly prepared sub-base is laid the concrete road, and here again no set rule can be given as to the proper shape and thickness of the road, but it has been found that a crown of 1/100 of the width of the pavement is ample to care for drainage and, except in extreme cases, should not be exceeded, as the low crown tends to keep traffic well distributed, thus making it a decided asset to any road. On country highways we specify a minimum thickness of 6 inches at the sides of the road, but this does not mean that on a well prepared subgrade the road must be 6 inches thick to withstand the

ordinary automobile traffic of rural districts. It allows a factor of safety to care for weaknesses in the preparation of the subgrade and for the contractor who often believes a 6-inch thickness means *about* 6 inches and then interprets it to 4½ or 5 inches.

The proper selection of materials is a subject to which considerable time could be devoted if at our disposal, as the quality of the aggregates is of utmost importance. The durability of the road depends upon the character of the concrete and this depends upon first the materials and second the workmanship. A few simple rules covering the most essential requirements for sand and stone are as follows:

First—The fine aggregate should be actually tested for mechanical analysis and tensile strength in mortar, because even the most experienced cannot always distinguish by appearance between good and poor sand.

Second—Use a coarse sand, free from fine particles; or screenings from hard durable gravel, granite, trap or other hard rock, with dust removed. An excess of fine material not only weakens the concrete, but will also form on the surface a layer or weak mortar having no wearing quality. Furthermore, it will retard the set, which is especially objectionable in cold weather. Even though the briquette test be high with a sand having a considerable proportion of fine particles, the mortar may not have good resistance to attrition or wear.

Third—The fine aggregate must be clean and should contain not over 3 per cent. by weight of finely divided clay, loam or other suspended matter. If it is not free from vegetable or organic matter it is liable to harden not at all or too slowly to be serviceable.

Fourth—An ideal sand would be one fulfilling the above conditions and composed of rough grains—to which the cement paste will adhere more rapidly—well graded from fine to coarse and having not more than 33 per cent. of voids.

The coarse aggregate should be a hard stone, such as granite, trap, gravel or hard limestone. This is necessary to resist

the wear and abrasion of hoofs and wheels. A very satisfactory stone is the crushed granite of New England or the hard limestone occurring in certain localities along the Hudson river and sold in New York as trap rock. A hard limestone cannot be cut with a knife and its specific gravity is high, say over 2.70. Although gravel does not bond quite as readily as broken stone nevertheless, with proper care, it makes a good surface.

Naturally mixed aggregates or "run of bank" gravel, no matter how tempting, should not be used unless they are washed and screened on account of the irregularity of practically every bank and the excess and varying amount of sand.

For communities where good material is not available at the average cost there has been designed the two-course type of construction, consisting of a 4 to 6-inch foundation course of the inferior local materials and a 2-inch top or wearing course of materials especially adapted to this use. This provides for the construction of a serviceable and durable road nearly as cheap as one-course roads constructed in localities wherein good materials abound.

I have said that the success of a road depends first upon materials and second upon workmanship, and by workmanship I mean the proper method of constructing and the proper supervision, which will insist upon strict observance of specifications or the carrying out of the methods described. The first question which arises in this connection is: In what proportions shall materials be mixed? The average engineer immediately recalls his favorite formula and puts in his specifications 1:2:4 or 1:2½:5, or whatever it may be. Now I wish to emphasize the fact that this should not be a hit or miss proposition. Concrete roads must stand not only tensile and compressive stresses, but wearing and abrasion, and to properly withstand these they should be built of the densest concrete possible without too great an excess of the matrix, and in order to determine this the aggregates should be tested for the percentage of voids. It is needless to say that only a batch mixer

can be used and each mix should be revolved a sufficient number of times to thoroughly coat the particles of stone with the matrix. Concrete mixed with an excess of water is easier to mix, to handle, to place and to finish than concrete of the proper consistency, and for these reasons there is a decided tendency to mix it too wet. This is a serious defect as it causes a separation of the coarse material from the mortar, resulting in stony pockets. It also allows the excess water to run over the side forms, carrying with it cement, and the water which does not run over collects in and hides depressions and inequalities in the surface, which cannot be detected until the water has evaporated. Furthermore, an excess of water will retard the setting of the concrete to the extent that it will not have sufficient tensile strength to counteract the shrinkage brought about by the subsequent rapid evaporation. The concrete should be placed as rapidly as possible in successive batches and spread to approximately the desired thickness in a continuous operation between transverse joints.

These joints are open to considerable criticism, much of which is warranted on account of lax methods employed in constructing them, but nevertheless until we can make a concrete not subject to changes in temperature and moisture we must allow for the contraction and expansion which takes place, and experience has demonstrated that unless provision is made for this change, a road will crack about every 30 feet. Therefore, a joint is essential and the type of joint to be used depends upon whether or not the road is to be maintained, or rather, whether a proper system of road maintenance is in vogue. If it is, the joint which has met with greatest success is one composed of a layer of bituminous felt, which is allowed to extend slightly above the surface of the road, and which afterwards is hammered down upon the rounded edges of the concrete, thus protecting them from wear. This protection must be removed from time to time by the application of a hot bituminous mixture. Where maintenance cannot be counted upon it is necessary to permanently care for these edges with

soft steel protecting plates, which are placed each side of the "filler" by means of an installing device supplied by the manufacturers of the plates. Neither type of joint is difficult to make, simply requiring the exercise of the care and precaution so often lacking in modern highway construction.

The road is finished or given its crown by means of a template or screed cut to the finished surface of the pavement and operated with a combined longitudinal and cross-wise motion. Two or more applications are necessary to secure the proper results. After the water has disappeared from the surface all slight irregularities are removed by means of wooden floats. The best working size is about 6x16 inches and the work of finishing must be done from a bridge spanning the concrete.

A feature often neglected in concrete work is the matter of curing and in road work this is a very important detail. Concrete must not be allowed to dry too rapidly, and consequently plenty of water should be sprinkled upon the road directly after hardening. In order to keep the surface wet and to obviate the necessity of continual sprinkling, a layer of at least two inches of earth or sand should be spread upon the surface as soon as the concrete is sufficiently hard not to be disfigured by this treatment. It should be kept wet for at least ten days, and, if possible, traffic should not be allowed on the road for an additional period of ten days.

We frequently hear it said "when in doubt reinforce the pavement." This is usually essential in a pavement 20 feet or more in width and serves as a factor of safety in any pavement. The reinforcement that has given the best results in this kind of work is a mesh composed of small wires, which, as a general rule, should be placed about 2 inches from the surface.

In conclusion, gentlemen, there is a phase of the concrete road proposition which we are bound to consider without regard to any theoretical or professional view we may entertain. It is the extremely important fact that many miles of this type of highway have been tested under practical conditions for

periods ranging from 5 to 20 years and that they have proved to be entirely efficient. The present situation as to concrete roads recalls the wide-spread discussion that took place some years ago concerning the fire-resisting properties of concrete. It was the consensus of opinion, after many laboratory tests had been made, that concrete would crack, spall and crumble under stress of fire. It remained for Professor Ira H. Woolson, then of Columbia University, to demonstrate the utter fallacy of our theories by making tests upon large specimens subjected to practical conditions, and it was found that concrete, especially cinder concrete, was the very best of modern fireproofing materials. We daily encounter grave discussion concerning cracks in concrete roads, but fail to realize that there is a vast multiplication of these cracks in every brick road, the mere regularity of pattern disguising that which becomes conspicuous in the concrete road. We fill the cracks between the bricks with a cement grout and the cracks in concrete with tar and sand. Concrete joints occur every 30 feet, brick joints every 3 inches. Thus we must not lean so far backward in our professional pride as to ignore the practical and common sense conclusions to which the taxpayers and users of these roads have come, namely, that they are the most durable and economical type of highway ever devised; that they are better fitted for horse and motor traffic than any other type of road; that they are passable at all seasons of the year, always free from mud and dust, never slippery and that they compare favorably in low construction cost with the best type of water-bound macadam roads.

CONCRETE PAVEMENTS.

By H. G. Lykken, *City Engineer, Grand Forks, N. D.*

The breaking down of the water bound macadam under the ever increasing motor driven and pneumatic tire traffic has resulted in the forced substitution of some more suitable road surfacing material. Portland cement concrete has received the benefit of this substitution, and is rapidly being pushed to first place among pavements in the point of yardage. It is only a question of a few years when it will be in a class by itself in this respect.

Taking it the country over, we now speak of concrete roadways, not in the terms of yards, but in the terms of miles, hundreds of miles. This development is not limited to rural conditions alone, hundreds of cities have laid more or less concrete pavements subject to a variety of traffic conditions.

The abundance, wide distribution and relative cheapness of the materials that enter into the construction of concrete pavements and the relative lower labor cost of construction is, of course, the main reason for its general adoption, especially for rural work. This same reason will make it the biggest factor in permanent road making in the future. It is the one biggest thing before the road and pavement engineer today.

All pavements, or nearly all, have their place when traffic conditions, climate, first cost and the many other factors entering into an intelligent choice of the best for the conditions in mind are taken into consideration. But here we have a pavement so much cheaper in the first cost, so eminently satisfactory under the great variety of conditions it already has been subjected to, that it is well worth investigating just what traffic and other limiting conditions it may be subject to before we pass it by for more expensive surfacings.

It would be absurd to claim that a concrete pavement is suitable for every urban condition, but it is a fact that it is suitable for a greater variety of conditions and worthy of greater consideration than that accorded by most engineers at the present time. It has been tried under the greatest variety of conditions with results that warrant a careful study before final limits for its usefulness are set. This, then is one problem before us.

Naturally with such a vast yardage of surfacing in which mistakes in the choice of material and in the manner of construction obtain, springing up over night as it were, all over the country, there is to be found much that is poor, or at best indifferent. There is not one of us that would admit that the best student of concrete surfacing among our most eminent road engineers knows all there is to be known about a concrete pavement, or could lay with uniform success with local material the best pavement in any given community. It is no wonder, then, that these pavements, so many laid by guess and mixed with faith rather than with intelligence, should show defects.

We still differ so greatly as to method and practices that there enter many problems demanding careful consideration.

This paper is intended to be suggestive, to open up the subject for debate. The choice of one side of any question is made for sake of brevity in argument rather than from assumption of authority.

First, the problem of traffic conditions to which a concrete pavement is adapted, will be considered. As a rural roadway there can be no longer any question of its adaptability and the writer is firmly convinced that it will never have a close competitor except in restricted areas where asphalt is a local product, or where the same can be said of good paving brick. For urban purposes its low cost and ease with which it can be kept clean places it first as an alley and court yard pavement. It approaches indeed an ideal pavement for this purpose, and it is the use to which it is most widely put to date in city work.

From this would naturally follow use in conditions somewhat similar, that is where the traffic is slow moving. It must be admitted that a concrete pavement is not suitable where there is more or less fast moving horse-drawn traffic. It is too hard on the horse, although the same can be said of brick or stone pavements. Nor is it suitable on heavy grades.

But in wholesale and factory districts where the traffic is largely motor-driven or slow, heavy trucking, the hard even surface of the concrete cannot be surpassed. With proper construction and proper materials used, it should wear as well if not better than stone or brick on account of the absence of joints. The one drawback is the greater difficulty of replacement when it does give out and the surface becomes too rough for further use. And here the writer wishes to raise the question, would it not be desirable to lay it in two courses, say six to eight inches of sub-base, then a wearing surface of four to six inches with a parting film of oil or asphalt so that the wearing surface could be stripped off as brick or wooden block surfacing. This would apply only to extra heavy traffic conditions.

On residence streets and all cross town streets where there is very little through traffic, or little horse-drawn traffic for any reason whatsoever, concrete forms an eminently suitable material. It is easily kept clean and sanitary, and it always can be made to look clean. To the writer its bright color, far from being an objection, is a desirable quality and makes for the beauty of the street, especially where wide green berms and trees are possible. It is often urged that concrete pavements are noisy. It is certainly not more so than brick, stone or even creosoted blocks.

To sum up, a concrete pavement with its low first cost and lasting qualities, second only to the highest priced pavements, demands first consideration for rural roadways; with the additional quality of ease of cleaning and looking clean it ranks high for alleys, court yards, cross town streets, wholesale and factory districts, and in fact all streets where the traffic is essentially motor driven or slow moving, and in residence districts where there is little or no through traffic.

Where there is considerable through or fast moving horse-drawn traffic, the more resilient pavements of the sheet asphalt or asphalt concrete type are without question the more desirable, as in busy business streets where the constant grind and pound demands incessant patching and repairs, some type of block, brick or stone will prove more satisfactory.

As to what enters into a good concrete pavement can best be considered under the following itemized subheads:

Material—Let us designate these as cement, fine aggregate, course aggregate, and to make it complete, water. It is understood that the cement is Portland cement of standard specifications, and that the water is just water if fairly clean.

It is the "fine aggregate" that is the hardest to pin down by a specification. It may be just bank sand, or sand with stone screenings passing a quarter mesh screen added in varying proportions. But this sand should be reasonably clean, free from organic matter and dust, contain not to exceed five per cent., and some allow up to eight per cent. of fine material. The grains should be angular rather than rounded, be fairly well graded as to size, contain a fair per cent. of what might be termed coarse sand or pea gravel. The material of the sand should itself be hard and tenacious.

What in fact is desired is a material that with the cement used will form the most tenacious mortar possible. The above specified qualities of the material are some of the things that contribute to this result desired, but may describe equally as well any of several samples varying greatly in value as a pavement material. For the reason that it is almost impossible to designate what shall constitute the "fine aggregate" and get this designation complied with by the contractor or material man, the writer under a following heading of "Proportions," wishes to suggest a method of specifying results rather than appearance of the material to be furnished.

"The "coarse aggregate" is more easily designated. This material should consist of some hard stone such as blue limestone, trap, granite or similar material. It should not be

brittle but tenacious. It should have an angular fracture, as near cubical as possible. The surface should be gritty rather than smooth. All material passing a quarter mesh screen and retained on a one and one-half inch should be eliminated. If gravel is used, the same specifications as to size and material should apply and all material should be fairly well graded.

In the above there is nothing that is not generally accepted, except the maximum size of stone. The writer thinks that a larger stone detracts from the strength of the pavement, makes it less homogenious and less even in its wear. In concrete where larger stones are used, these form only a small percentage of the whole mass. They are isolated bodies in the bulk of the material. Now this bulk of the material determines the character of the pavement, its strength, its wear and its lasting qualities. A larger stone is a foreign body. If harder or softer it is a detriment. There is always a chance that such larger stones have incipient cracks, that they may be jarred loose if near the surface.

Proportions—The proportion requiring one bag or hundredweight of cement to each four cubic feet of concrete in place seems to form a happy medium in pavement specifications. There may be certain conditions of traffic, of the aggregate used as well as numerous other things that would demand a slightly richer mix. Then again some conditions might warrant a slight saving in cement.

The writer prefers to think of concrete as consisting of two elements, the motar consisting of the mixed fine aggregate and cement, and the coarse aggregate forming the skeleton as it were. In the concrete this mortar or magna fills the voids in the coarse aggregate and slightly to excess, binding the particles together.

The vital element of strength and durability is this mortar, in its hardness, in its toughness, in its tensile strength, in its cementious qualities as affecting the particles of the coarse aggregate.

The writer therefore suggests placing a specific requirement upon this mortar as used in the pavement rather than upon the various raw materials of which it may be composed. We no longer specify of what Portland cement shall be made, nor the manner of its making. We deal directly with the finished product as we use it. So here, we care little as to what the specific ingredients are, or the proportions used, if the finished product, the mortar, comes up to certain tests as to strength and durability.

If this mortar has a tensile strength of say one hundred pounds per square inch when tested at the end of forty-eight hours in air under standard conditions, if it stands up under all of several tests that may be applied to determine its soundness, the effect of heat and moisture, and even a modified abrasion test, we have not only a test of the cement, its sand carrying qualities, a test of the many qualities of the sand or fine aggregate, but also a test of the proportioning.

It is hard to say why two sands looking much alike, so much so that you cannot make a contractor use one in preference to the other if it costs a trifle more, should not give an equally strong mortar, but they do not. In specifying results it is no longer a matter of appearance of the material but what it will do.

Mixing.—All engineers agree on the proposition of thorough mixing, but it is surprising how many still cling to the old specifications requiring a mix dry enough to require tamping, "tamp till water flushes to the surface." There is no question but that the tendency of modern practice is towards the use of a wetter mix, using water enough so that the mineral particles can adjust themselves and form a dense body by settlement rather than by manual compression.

Here, too, we have, of course, a happy medium. The concrete should be in condition to trowl shortly after initial set begins, and the concrete mass must have body enough to hold the contour of the street when screeded off.

One or Two Course—There have been and are yet two schools of concrete paving engineers, one prefers the two course pavement, and the other advocates the one course, although the tendency is decidedly in favor of the latter.

Evidently the sole object in laying a two course pavement, except in a few cases where a different aggregate is desired in the surface, is to save cement by using a leaner mix in the first course. In a seven inch pavement where five inches is mixed one to seven, and the top two inches one to three and one-half, as an example, there is saved only approximately fifty pounds of cement per square yard, which is materially reduced by cutting down the thickness of the pavement to, say, six inches which would be equally as strong with the richer mix. Now this amount of cement in most cases will little more than pay the extra cost of labor in laying the two course over that of laying one course pavement. It means a double crew and equipment or a constant change from one mix and one routine of work to another.

In the writer's opinion the one course pavement is the better type and only in rare cases more expensive, even with the richest mix desired in the surfacing. Considerable difference in thickness can be allowed for as a compensating element in the cost. With the one course pavement uniform results are obtainable. There is never any danger of a thin top, dust film on, or drying of the first course before the second is applied, and many other elements of chance entering into the construction of the one which are absent in the other.

Thickness—Seven inches seems to have come in as a sort of acceptable standard of thickness. Whether it has any relation to the mystic number seven of the ancients or not is hard to say. However, there are conditions when a thinner pavement may be equally serviceable, especially the more richly mixed one course pavements. In the South where there is no frost action and under conditions where the traffic is not excessive five inches, and even four may be satisfactory. The writer has seen a concrete pavement in a small city in Northern Min-

nesota five inches thick showing no cracking or breaking of the slabs after several years' service.

But there are conditions where more than seven inches is to be desired. With very heavy traffic, especially on yielding foundation, the slab should be thick enough not to throw excessive compression strains into the surface in addition to the downward compression of the wheels.

It may be suggested again at this point that for heavy traffic, a two course pavement having a five to eight inch base and a four to six inch top separated from the base by an oil or asphalt film so that the surfacing could be readily removed when worn out, is worthy of consideration.

Reinforcement—The writer has little faith in the value of reinforcement although having used same in a considerable yardage of concrete pavement. The high cost prevents the use of enough steel to make it of any value. There cannot be any particular advantage in making the slabs so large that steel is necessary to take care of the contraction strains. As for expecting the steel to prevent breaking of the slab from heaving by frost or settlement of foundation or other strains due to undistributed support, seems absurd from every consideration. As the slab may be a beam supported either at the center or at either edge as the conditions of the undistributed support vary, the upper and under side of the slab are subject to compression and tension alternately, a condition requiring reinforcement both in the upper and under surface which would be prohibitive in cost, or putting it in the middle plane of the slab as a compromise. In the latter case we have a beam of an effective depth of three inches in a seven inch slab which is wholly inadequate to carry the dead weight and can in no way prevent its breaking.

Such reinforcement can have no value in preventing cracking or breaking due to undistributed support and its cost should rather be put into additional cement or greater depth.

Surfacing—Much concrete pavement is still being put down with surface marking made in imitation of brick with a poor

job of joint filling. It is surprising how many people still think that it is necessary to groove a concrete pavement even on no grade to give foothold for horses. A concrete pavement with an even broom finished surface gives an excellent foothold for horse traffic. It is less slippery than asphalt, creosoted wood block, and even brick when laid with full grouted joints. It is in fact less slippery than much of the blocked concrete pavements. The writer has used broom finished concrete for floors back of the stalls and in the runway in fire halls with no complaint of slipping even on part of the prancing fire horse.

Jointing—The one generally accepted reason for not laying a continuous pavement is that contraction must be allowed for. (Expansion is advisedly not considered as it can be amply taken care of transversally.) This contraction would crack the pavement at right angles to its course at varying intervals depending upon the frictional resistance of its base and its inherent tensile strength. Providing a contraction joint every thirty feet is well within the margin of safety in taking care of such cracking.

In the northern portion of the country, however, where the frost penetrates into the soil below the pavement, we have a more serious cause of cracking. Every kind of soil expands to some extent upon freezing as all soils contain more or less moisture. The clays especially remain moist no matter how well drained.

At Grand Forks, North Dakota, where the soil is a heavy clay and the frost penetrates four to five feet, the surface heaves or rises three to four inches due to the expansion of freezing. This means that all pavements and structures above the frost line are lifted three to four inches in the winter and settle back in the spring. This condition is more or less true where there is any freezing of the soil.

Now as the freezing in winter or the thawing in spring is never uniformly distributed, or the soil absolutely uniform in composition, density or moisture content, the heaving and sub-

sidence will vary causing strains of undistributed support in the pavement slab. The writer has observed numerous cases where one slab has been lifted as much as two inches above the adjoining one, or one part of a slab broken by the frost lifted above the other part. This is especially noticeable in the spring when the frost is going out, which is in fact the time of the year when the irregularity in heaving seems most pronounced. Eventually the slabs return to their normal position.

In a slab thirty feet square and seven inches thick weighing thirty-five to forty tons, it is patent that breaks must develope when the support comes in any one portion.

Only one remedy for this condition suggests itself and that is a smaller slab. The weight of the slab must not exceed its strength acting as a beam with any possible point of support. A slab fifteen to sixteen feet square will meet this requirement and where the heaving is not excessive a slab even twenty feet square. This means, of course, a longitudinal joint in the street as well as the more frequent transverse ones.

Determination of the most suitable joint or armour for same becomes necessary. If steel is to be used, its construction and temper should be such that the joint would wear uniformly with the pavement surface. On streets with an ordinary amount of traffic, no armour would be necessary on the longitudinal joint other than some form of parting strip.

Broken stone, gravel, sand, cement and water, all mixed in the proper proportions, makes good concrete, and good concrete makes a good roadway, but there are a surprising number of details necessary to know and many yet necessary to learn before we obtain the best results with concrete as a pavement material.

EXPERIMENTS ON THE BLEEDING AND SWELLING OF SOUTHERN YELLOW PINE PAVING BLOCKS

By C. H. TEESDALE, *In Charge of Wood Preservation Forest Products Laboratory, Madison, Wis.*

INTRODUCTION.

When the use of creosoted wood blocks in the construction of street pavements became of commercial importance, two difficulties developed which have seriously retarded the industry. These were the bleeding of oil from the blocks, and the expansion of the wood due to absorption of moisture after being laid in the street. Numerous theories were advanced to account for these difficulties, but these were in many cases unsupported by facts, and did not give rise to methods that prevented the trouble. Work was therefore started at the Forest Products Laboratory to determine the cause, if possible, and to devise methods of preventing it.

The laboratory work was separated into two classes of tests, those on bleeding and those on swelling. The tests were made principally on long-leaf pine treated with coal-tar creosote and mixtures of coal-tar creosote with tar. Only a limited number of blocks could be used in each laboratory test. It was necessary, therefore, to resort to very careful matching of blocks. Much of the data obtained is not included here in order to save space. The curves given, however, are representative of all that were obtained. The results in themselves can not, of course, be considered final. It will be necessary to obtain results from service conditions before final recommendations can be made. With this idea in view, the laboratory tests were supplemented by a test in a commercial plant, and by laying a test pavement in Kansas City, Mo., in co-operation with the Kansas City Terminal Company. The results of this test are not as yet available.

Scope Of Work.

The investigation on bleeding was intended to cover those factors entering into the selection of material and its treatment

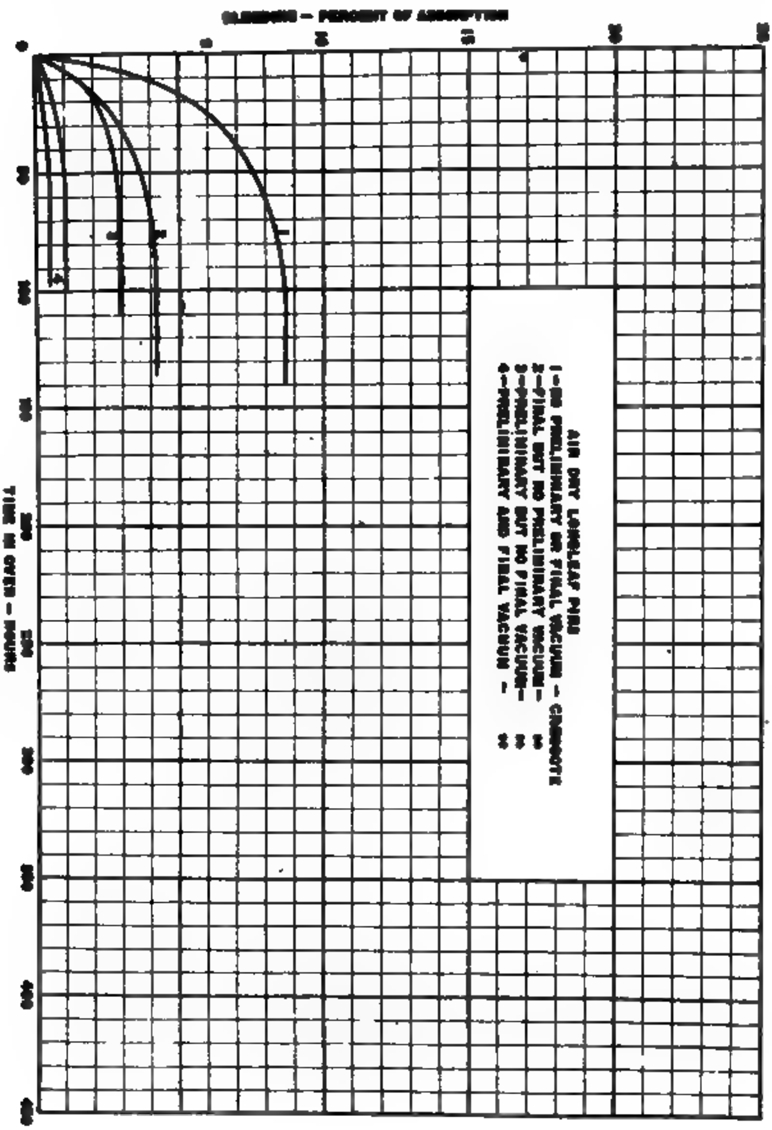

Fig. 1. Effect of Vacuum on Bleeding.

at the plant that might have an influence on bleeding and swelling. Briefly, these were the following:

1. The influence of species and rate of growth, which was covered very briefly.

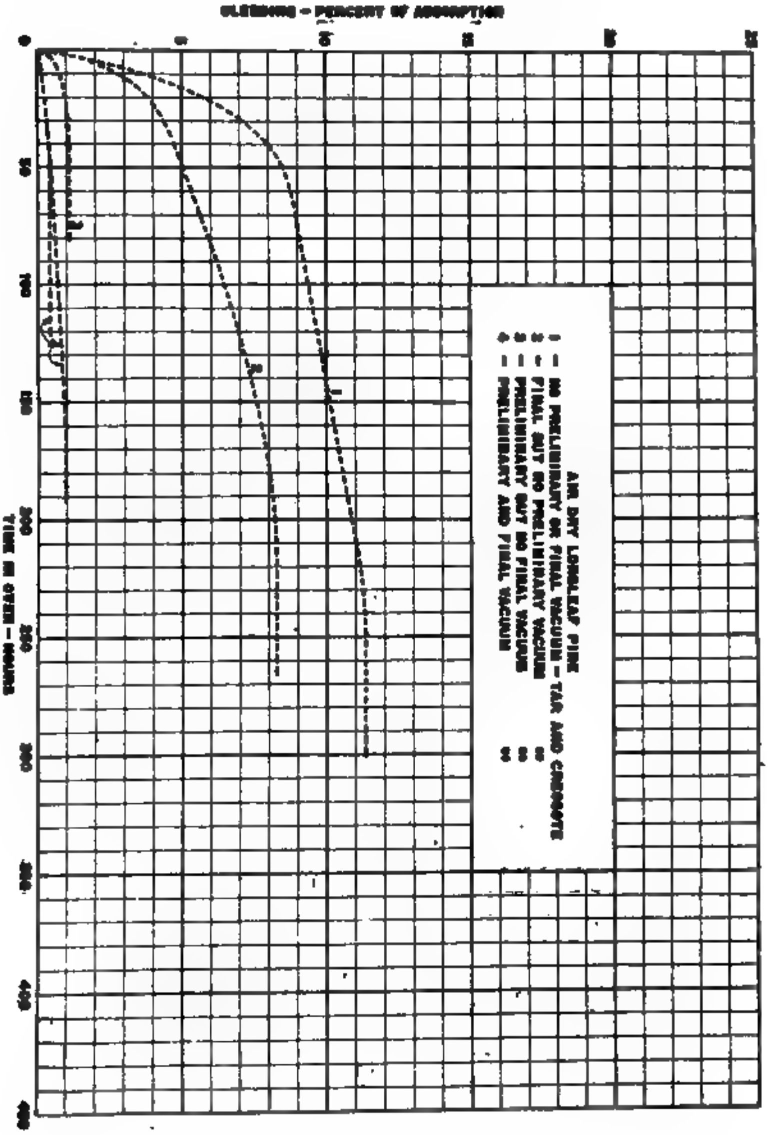

Fig. 2. Effect of Vacuum on Bleeding.

2. The moisture condition of the wood when treated. Green and air-dried wood was tested.

3. The character of preservative used. A distillate creosote oil and a mixture of this creosote with tar, as representative of a paving oil in general use, were tested.

4. Manipulative methods employed in treatment, especially the use of steam and vacuum treatments and preliminary air pressures. In addition tests were made to determine the effect of varying the absorption of preservative, and of subjecting treated blocks to external pressure, a condition some times obtained in a street when the expansion trouble exists.

The investigation of swelling of paving blocks included tests to determine the effect of mixing tar with creosote and also the effect of free carbon in the mixtures. A few tests were made on the effect of varying the methods of treatment, and the absorption of preservative on swelling. In these tests some of the blocks were soaked in water, and others were placed on a sand cushion and sprinkled daily until they ceased to expand.

Materials Used.

Green long-leaf pine and thoroughly air-dried* long-leaf pine, rapid growth loblolly pine, and eastern hemlock were used in the work. Standard long-leaf pine paving block stock was used where possible. The blocks used were 4 inches wide, 8 inches long, and 4 inches deep.

Two preservatives were used in the investigation of bleeding. One was a coal-tar creosote with a specific gravity of 1.07 at 60 Centigrade. The other was a 50 per cent. mixture of this creosote with a by-product coke-oven-tar having a specific gravity of 1.17 at 60 degrees C., and containing about 6 per cent. free carbon. This mixture was believed to be comparable to much of the paving oil used for treating blocks.

*The moisture content of the air-dried wood was not determined. This material was air-dried when received, and was held in the laboratory for nearly a year before making tests. It was, therefore, thoroughly air-dry.

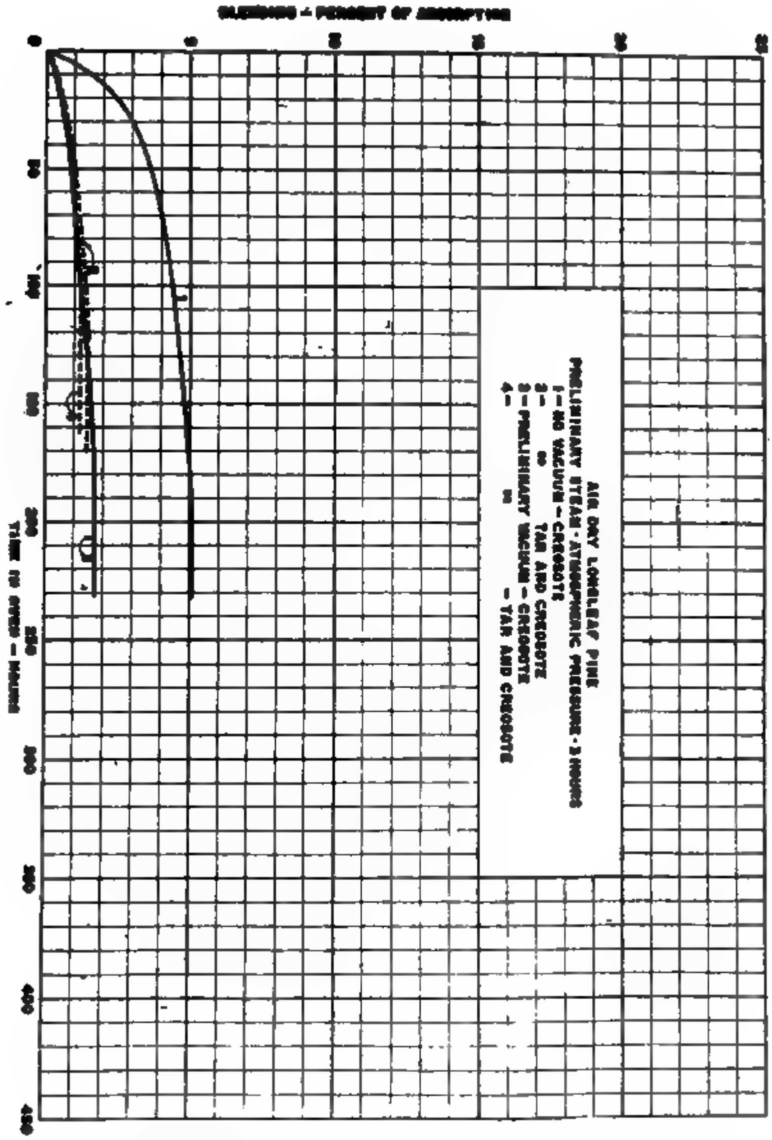

Fig. 3. Influence of Steaming on Bleeding.

In the investigation of swelling, a gas house tar† was used which contained 30 per cent of free carbon. The carbon was

†Tests were also made with the by-product tar used in the bleeding tests. Those obtained on gas house tar are included here because of the greater carbon content, to save space, the others were not included; the results obtained were similar, however.

removed from a portion of this tar with chloroform. (See paper by F. M. Bond, Proceedings American Wood Preservers' Association, 1913, for method used). This carbon-free tar was then mixed with the above coal-tar creosote in proportions as follows:

Creosote	Carbon-Free Tar
Per cent. of total mixture by volume.	Per cent. of total mixture by volume.
100	0
75	100
50	75
25	50
0	25

In the tests to determine the influence of free carbon on swelling, the carbon-free tar was mixed with the original tar in various proportions. The per cent. of carbon in these mixtures was determined by analysis. These tars were then mixed with coal-tar creosote, the proportions being 50 per cent. creosote and 50 per cent. tar in each case. In this manner it was possible to obtain a series of oils, the composition of which were the same except for the content of free carbon.

Method Of Conducting The Work.

Careful matching of specimens was necessary, because of the limited number of tests made. It has been found that the most uniform absorptions and penetrations are obtained when the specimens are matched lengthwise with the growth of the tree. This method of matching was, therefore, adopted in these tests. In the case of long-leaf pine, paving stock 4" x 8" x 2' was used, and all of the blocks cut from one stick were considered matched with each other. In the case of the other species ties were cut into sticks 4" x 7" and all of the specimens from one of these sticks were considered matched.

The blocks were treated in a small exprimental cylinder in which pressure and temperature conditions were under accurate control. The preservative was applied to the blocks under a pressure of 140 pounds per square inch until the desired absorption was obtained. A temperature of 180 degrees F.

was maintained throughout the treatment. When preliminary vacuums were drawn, the period was one hour, and the intensity 26 inches unless otherwise stated. Steam periods and pressures are stated on the figures in each case. Two blocks were included in each treatment.

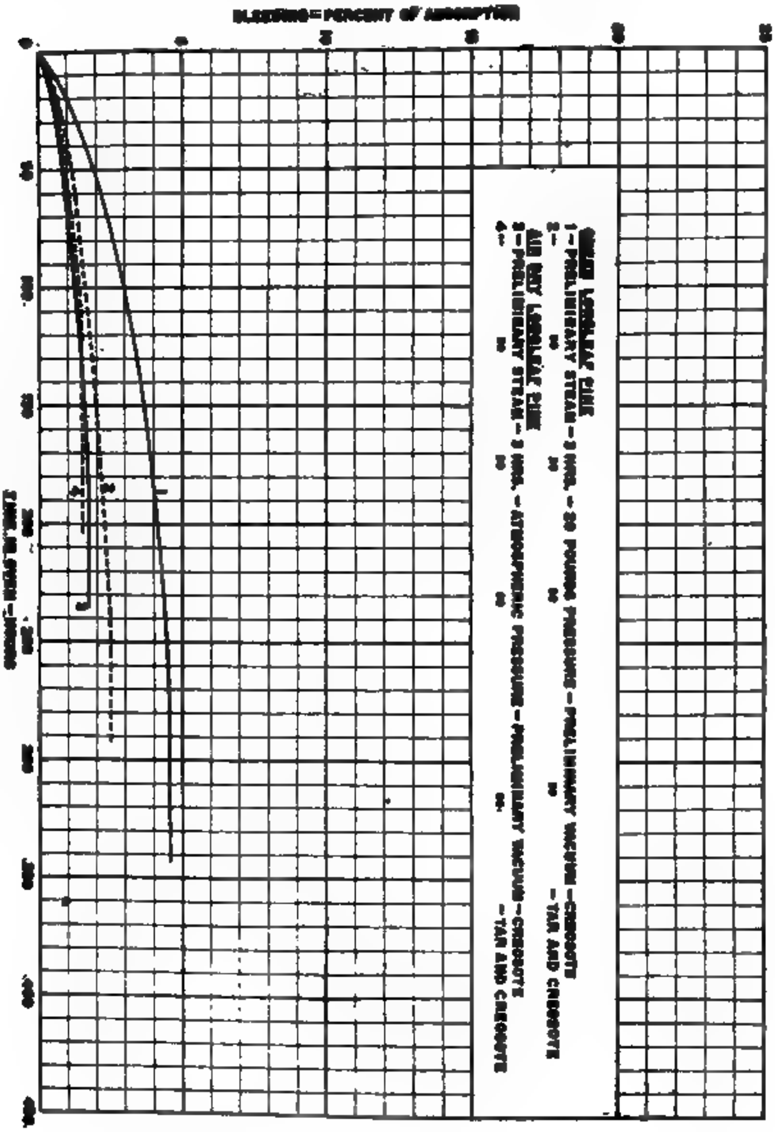

Fig. 4. Bleeding of Green and Air-Seasoned Blocks.

Method Of Making Bleeding Tests.

After treatment the blocks were placed in an oven in tin boxes, and subjected to a constant temperature of 120 degrees F. until the oil ceased to bleed from them. Blotting paper was used to absorb the oil as it came from the blocks. Weights were taken at suitable intervals, corrections being made for losses by volatilization. In the data presented, an average of two blocks was taken in each case.

Method Of Making Swelling Tests.

After treatment brass tacks were driven into each face of the blocks to facilitate measuring. All measurements were made over these tacks with a vernier caliper to .001″.

Two kinds of tests were made. Some of the blocks were allowed to soak in water until they ceased to increase in size. The remainder of the blocks tested were placed on a sand cushion and sprinkled daily until expansion ceased. Measurements were made at frequent intervals at first, these intervals being lengthened when the blocks changed in volume less rapidly. In the curves presented, the area of the transverse section of the blocks was used. The increase of this area in per cent. of the area of air dried, and the number of days of soaking were used as co-ordinates.

Discussion Of Results.

Bleeding Tests.

The results obtained from the bleeding tests are given in the attached curves, measure of bleeding being taken as the gain in weight of blotting paper in per cent. of the original absorption of the block. Since the absorption in each case was about 16 pounds per cubic foot, the results are considered comparable with each other and no corrections were made for the slight variations obtained. In the following remarks air-dried long-leaf pine is referred to unless otherwise stated. The data on blocks treated with creosote are shown in solid lines, and on those treated with tar and creosote mixture in dotted lines.

The effect of the use of vacuum periods on bleeding is shown in figures 1 and 2. All of the results given in both figures were obtained on matched specimens and are, therefore, comparable with each other. In every case a preliminary vac-

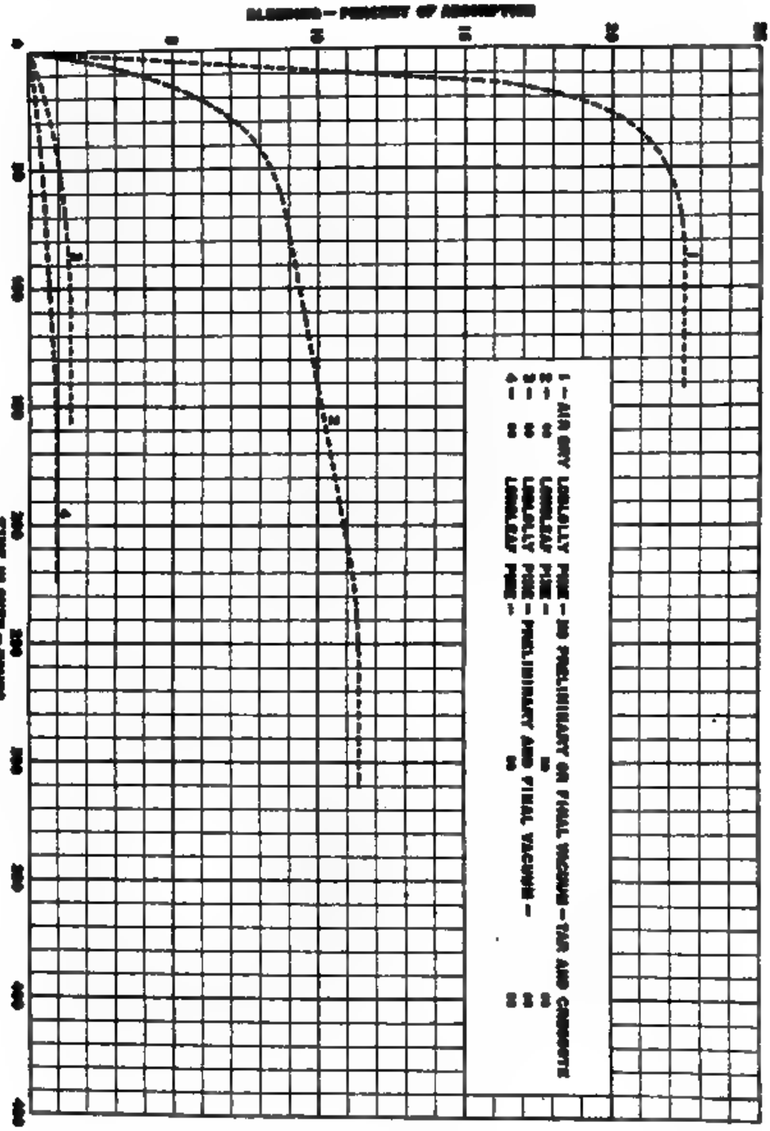

Fig. 5. Bleeding of Longleaf Pine and Rapid Growth Loblolly Pine.

uum was more effective than a final vacuum. Two check runs are shown in curve 4, figures 1 and 2. The least bleeding, however, was obtained when both vacuum periods were used. The results shown on figures 5 and 8 also show the effect of vacuum on the bleeding of loblolly pine and hemlock. The results indicate that a preliminary vacuum especially is a very important factor in treating air-dry paving blocks if bleeding is to be reduced.

The influence of steaming on bleeding is shown in figure 3 in the case of air-dry long-leaf pine. These curves should be compared with curve 1 in figures 1 and 2, all of the blocks being matched with each other. Steaming, when used without a vacuum period, (curve 1 Fig. 3) was not very efficient in reducing bleeding when creosote was used. With the tar and creosote mixture, however, (curve 2 Fig. 3) the reduction in bleeding was very marked. Steaming evidently has a much greater effect on the tar and creosote mixture than on the creosote.

The use of steam followed by a preliminary vacuum is also shown in figure 3. A vacuum period after steaming assisted somewhat in reducing bleeding, especially when creosote was used (compare curves 1 and 2). With either preservative bleeding was almost negligible. It should be noted that a vacuum period is necessary after steaming the blocks in order to remove excess of moisture. All of the blocks in figure 3 were matched with each other.

Comparisons of the bleeding of green and seasoned blocks are available only for a few runs on long-leaf pine in which steaming treatments were made. The results are given in figure 4. The least amount of bleeding was obtained on air-dried material (curves 3 and 4) and the greatest amount on green material treated with creosote (curve 1). With either green or air-dried material, and with either the creosote or the tar and creosote mixture, bleeding was greatly reduced when both steam and vacuum treatments were applied. All air-dry blocks were matched, and all green blocks were

matched. The air-dry blocks, however, were not matched with the green ones.

The influence of rate of growth was studied only by comparing the results of the tests on long-leaf pine and rapid

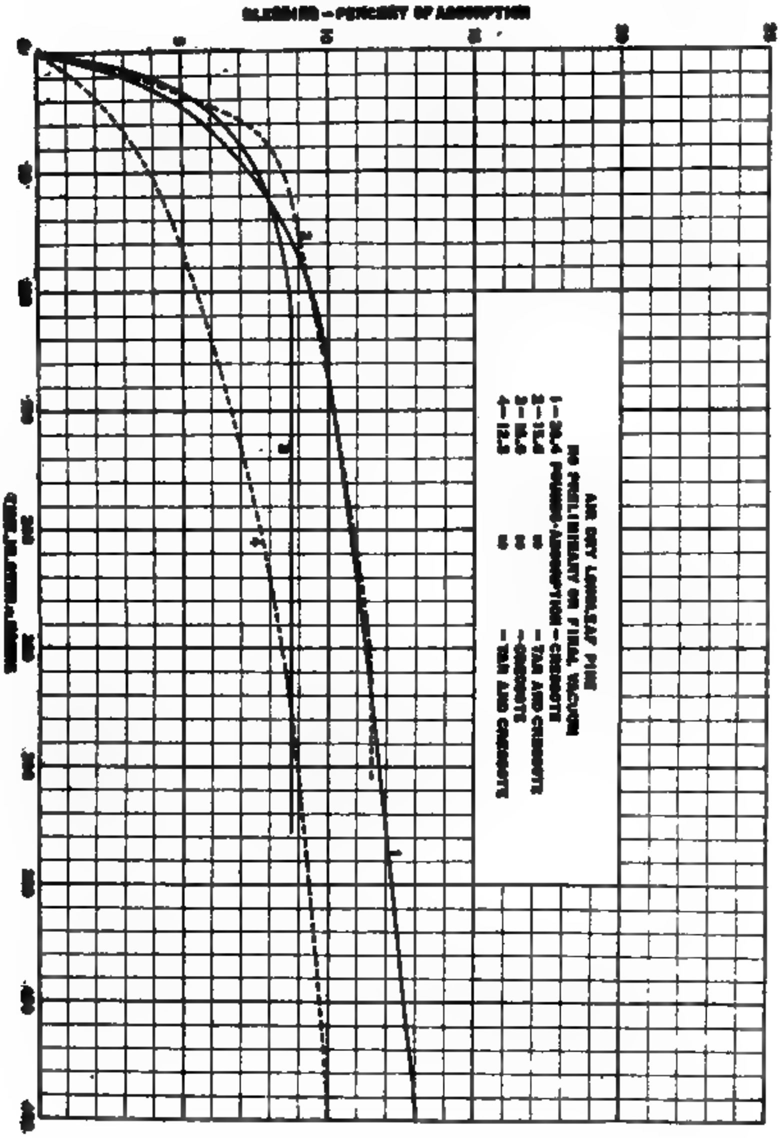

Fig. 6. Effect of Varying Absorption on Bleeding.

growth loblolly pine in figure 5. It will be noted that the loblolly pine bled very much more than the long-leaf pine when no preliminary vacuum was used. When preliminary vacuum was used, the absorption could not be controlled and 40 pounds per cubic foot was absorbed. While the per cent. of bleeding was reduced the total amount of bleeding was, therefore, still very large.

The influence of the amount of preservative injected is shown in figure 6. Bleeding was materially increased when absorption was increased, especially when more than 16 pounds per cubic foot was injected*, or when the tar and creosote mixture was used. Compare curve 1 with 3, and curve 2 with 4; additional data on this point were also obtained, but are not included because of lack of space.

The effect of outside pressure, intended to show the effect of the expansion of blocks in the street on bleeding, did not appear to have much influence on bleeding. The blocks in thise case (air-dry long-leaf pine) were compressed in an iron clamp until the wood was crushed. This extreme condition would not be reached in the street. Nevertheless, bleeding was not greatly increased. The results are given for both oils in figure 7. Compare curve 1 with 2 and curve 3 with 4; curve 1 can not be compared with 3, nor curve 2 with 4 as the blocks were not matched in this way.

The bleeding of oil from hemlock is shown in figure 8; without the use of vacuum, bleeding was very severe (curves 1 and 2). A preliminary and final vacuum, however, reduced it to a minimum (curves 3 and 4). All of these blocks were matched with each other.

The effect of mixing tar with creosote is shown by comparing the results in all of the figures from 1 to 6, inclusive. When no preliminary vacuum or steam treatments were used, the blocks treated with tar mixtures in most cases bled considerably more than those treated with creosote; this was true

*It should be noted that when the absorption was increased, the amount of bleeding could also increase without showing an increase in the per cent. of bleeding.

regardless of species. Steaming blocks prior to treatment appeared to have a very marked retarding influence when tar was used. The tar appeared to dry in the outer pores of the wood, forming a mat that retarded bleeding.

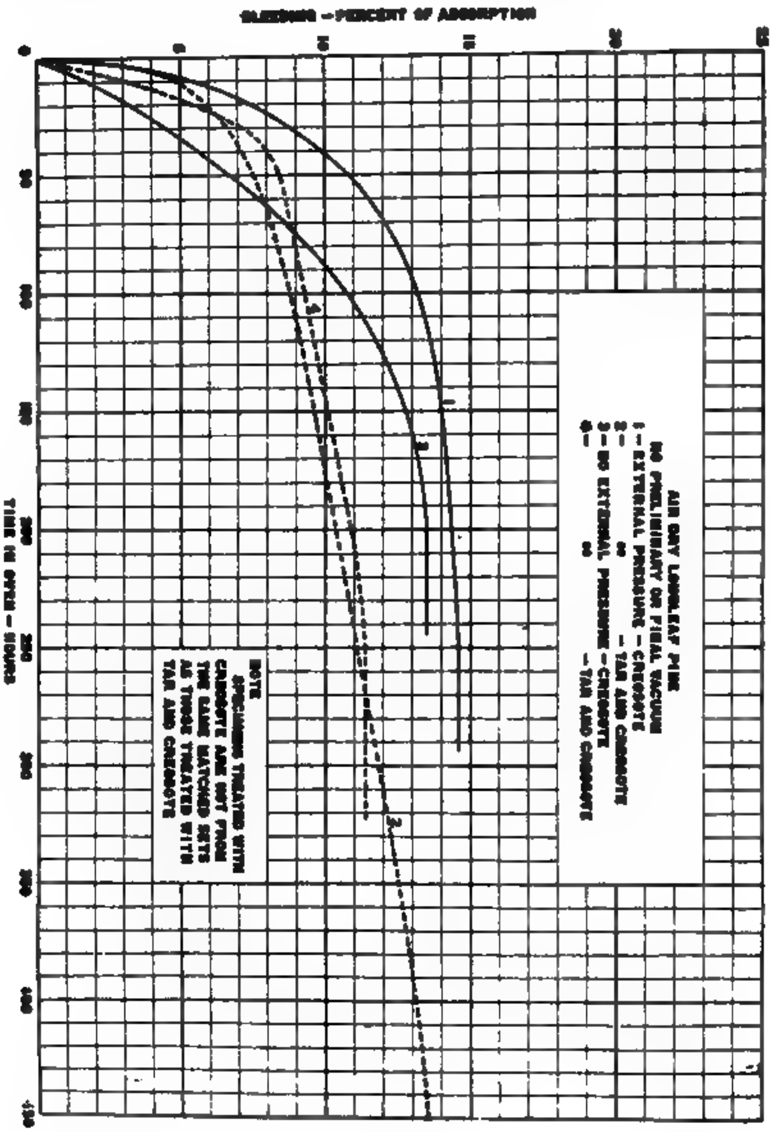

Fig. 7. Effect of External Pressure on Bleeding.

The use of a final steam bath did not influence the bleeding materially, but removed carbon from the surface, and greatly improved the appearance of blocks treated with the tar mixture. The data on this point are not given in the figures.

All of the results seem to indicate that bleeding is caused to a large extent by the expansion of air in the wood cells. Other contributing causes which no doubt aggravate bleeding are expansion of the preservative in the wood, external pressure exerted upon the blocks, excessive absorption of preservative by some of the blocks, and the use of rapid growth woods. Sapwood is also a factor, largely because of the excessive absorption of oil that it takes.

Swelling Tests.

The results of the swelling tests are shown in figures 9 and 10. In both cases the blocks were soaked in water. The complete data on the tests in which the blocks were placed on a sand cushion are not as yet available.

Figure 9 shows the effect of mixing carbon-free air with creosote on swelling; untreated blocks are included for comparison. The expansion of untreated wood was comparatively very rapid, reaching 80 per cent. of the maximum in ten days, and the maximum in forty days. The maximum with creosote was reached in four months, and with tar and creosote mixtures in 7 to 8 months. The maximum swelling of the blocks treated with creosote was a little less, and the rate of swelling considerably less than in the untreated wood.

Taking into consideration the discrepancies which can not be avoided, because of the uncertain variability of wood, we may conclude that increasing tar in a tar and creosote mixture tends to reduce the rate and the total amount of swelling.

Figure 10 shows the effect of free carbon on swelling. It was found that free carbon had very little influence on swelling. The results obtained were variable, and seemed to have, but little relation to the carbon content. The variability

seemed to be due to a mat of carbon which formed during treatment and clogged up the pores of the wood causing uneven penetration.

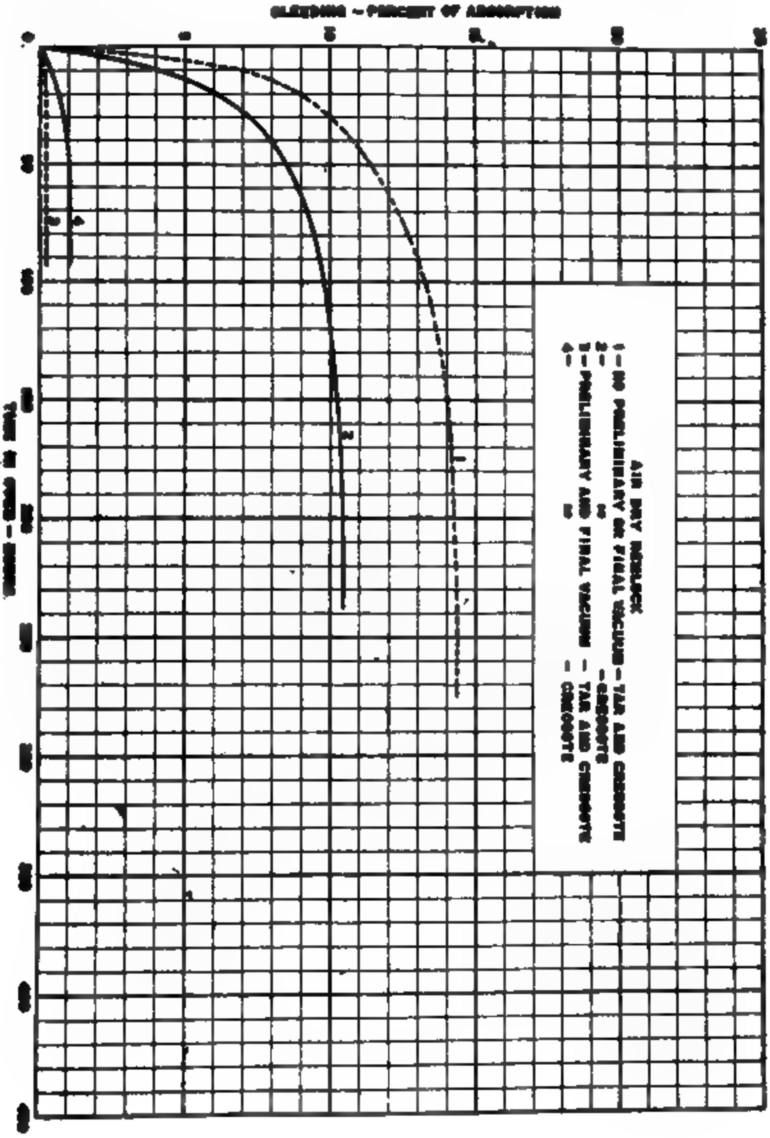

Fig. 8. Bleeding of Air-Dry Hemlock Blocks.

Tests similar to those described here were made on two other tars, but are not included because of lack of space. The conclusions were similar in all respects, however, and substantiate those stated here.

The following conclusions were drawn as a result of all the tests made on swelling:

1. The rate of swelling was much slower in treated blocks than in untreated blocks. In all cases where the blocks were soaked in water the maximum swelling obtained was at least two-thirds, and in most cases was only slightly less than that of untreated wood.

2. The maximum swelling was less in blocks treated with tar mixtures than with creosote.

3. Free carbon did not appear to influence swelling.

4. No swelling occurred in the case of wood treated in green condition (data on this point not shown).

Test Pavement.

After the laboratory tests were concluded, arrangements were made for the treatment and laying of an experimental pavement in co-operation with the Kansas City Terminal Company at Kansas City, Missouri. The blocks were treated by the Ayer and Lord Tie Company at Argenta, Ark., under the supervision of a representative of the Forest Service, as follows:

One section of green long-leaf pine blocks was treated with paving oil, and one with a distillate creosote oil furnished by the Barrett Manufacturing Company. The blocks were given a steam treatment and a preliminary and final vacuum. A third section of air-dry blocks was treated with paving oil without steaming or vacuum treatments. About 300 square yards were treated for each section. These blocks are being laid at the present time and results on bleeding are not as yet available. Their appearance, however, is very indicative. Those treated without steaming or vacuum were covered with a layer of tar and difficult to handle. The others were dry and clean, no pitch or tar being present on the surface.

General Conclusion.

These tests seem to indicate that longleaf pine paving blocks should be treated in the green condition after being well steamed. All blocks, even if thoroughly air-seasoned,

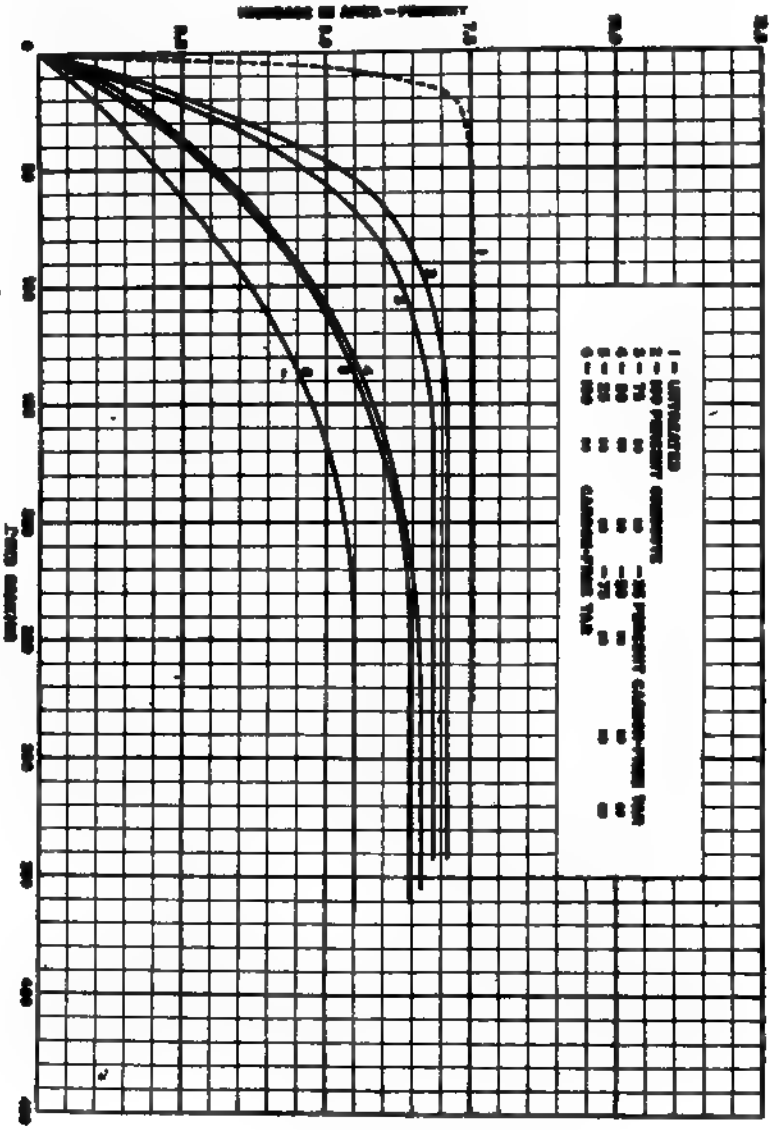

Fig. 9. Effect of Various Mixtures of Carbon-Free Tar With Creosote on Swelling.

should be well steamed. While it is true that a preliminary and final vacuum greatly retarded bleeding of air-seasoned wood, a preliminary vacuum will tend to make the absorption of oil too rapid during treatment, resulting in uneven penetration. A steaming period is, therefore, advisable to render the absorption less rapid and allow a longer and more intense pressure period to be applied. Furthermore, if seasoned blocks are steamed, they will take up moisture and expand and should be less liable to give trouble from swelling after laying in the street. For these reasons it would be preferable to treat green material when it is possible to obtain it.

If for any reason the blocks can not be laid soon after treatment, they should be covered and perhaps wet down occassionally to prevent them from drying out. It is likely that if the blocks are wet when laid, expansion troubles will be much reduced, provided a good job of laying is done.

It would seem to be desirable to give a vacuum treatment after the steaming period and also after the oil has been removed from the cylinder. If tar mixtures are used, a final steam bath should succeed the final vacuum to remove carbon and dirt from the blocks.

Absorptions of over 16 pounds per cubic foot hardly seem necessary. Data are available which show that heavier absorptions do not greatly retard swelling and they tend to increase bleeding.

It seems very likely that the reasons why some pavements bleed while others do not may very often be traced to the method used in treatment. A plant treating green material would resort to a steaming and vacuum treatment with the result probably that the blocks would give no trouble. The same plant, perhaps, would later treat seasoned material without steaming it or giving it a vacuum treatment. This would be the simplest method of treating such timber as much time would be saved, and these operations would seem unnecessary. When such blocks are placed in the pavement, however, there is considerable probability that bleeding would follow. The

author hopes that this society will consider the advisability of adopting a standard specification for treatment that will take into consideration the influence that methods of treatment may have, both on bleeding and swelling. The Forest

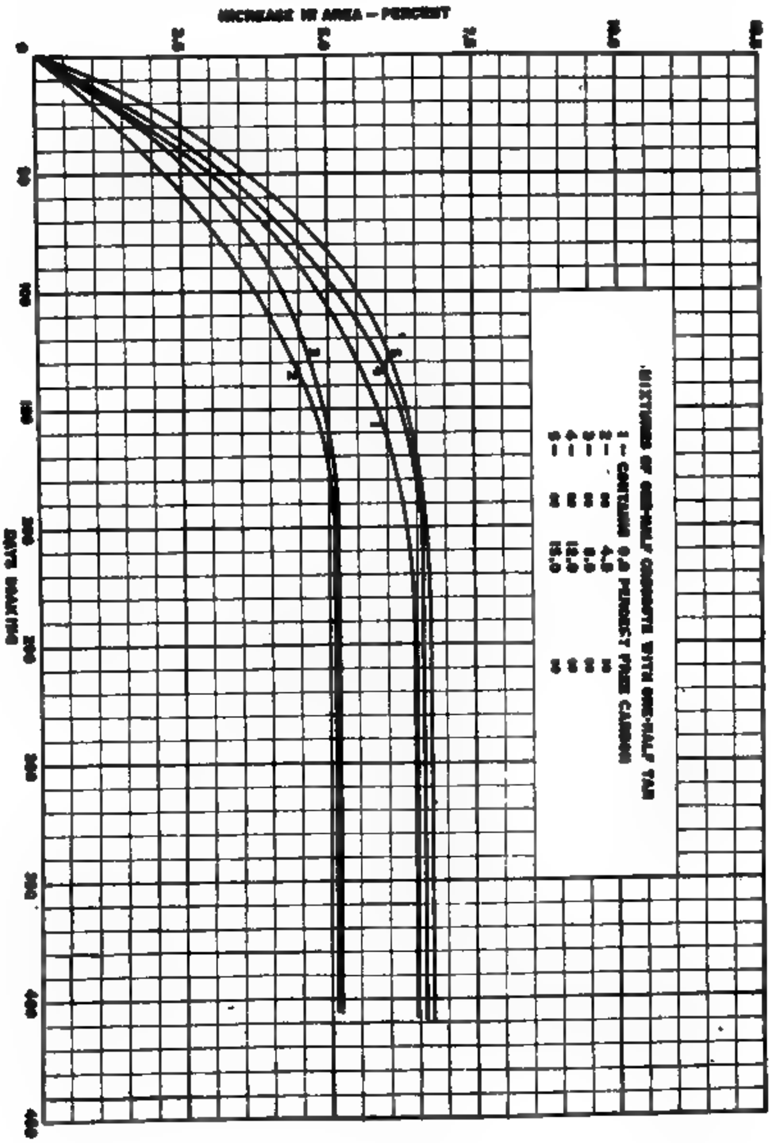

Fig. 10. The Effect of Free Carbon in a Tar and Creosote Mixture on Swelling.

Products Laboratory will be very glad to co-operate with the association to the fullest extent in drawing up such specifications.

DISCUSSION.

MR. HOWARD: Did you put blotting paper all around the block, or only underneath?

MR. TEESDALE: Only underneath.

MR. HOWARD: And what ran down you measured?

MR. TEESDALE: Yes, sir.

MR. HOWARD: Did you suspend the blocks in the oven, or lay them on the blotting paper?

MR. TEESDALE: We laid them on the blotting paper, on the end surface, and they were turned over every day.

MR. HOWARD: How would it do to wash it off with benzol first, to get it clean, and then weigh the block, and then put it under heat, and at periodic intervals take it out, and wash off the exuded tar with benzol, evaporate your benzol and weigh what is left? That gives you the amount of oil, and add the oil up at the end to see what oil was used.

MR. TEESDALE: I do not think that that would be necessary.

MR. DOW: It seems the expansion causes bleeding, no matter what the treatment has been, whether they have been steamed first or not. I have seen blocks lying on the street in hot weather for days at a time, and not a particle of bleeding, but as soon as put into the street and tightened up in the pavement, and expansion took place, they started bleeding; and those blocks had been treated by the steaming process first.

MR. MACALLUM: What percentage of cost would be added to steam all the blocks?

MR. TEESDALE: I do not know that. Perhaps some of the producers here can inform us.

MR. LOUD: The cost of steaming all blocks is not excessive. It is almost necessary to steam blocks, if they are dried at all,

to get uniform penetration. The usual run of lumber is 15 or 20 per cent. of sapwood, and if the lumber is very dry and is treated without steaming, the sapwood will take up most of the oil, and the heart wood will be robbed; so in order to get good penetration it is necessary to steam the blocks beforehand, and the cost does not amount to much.

Mr. Dow: The dry wood is very much harder to treat than is the green wood, and it is possible that is the reason for some of your results here, that all the oil stayed in the outside courses of that block, and then was easily forced out.

Mr. Teesdale: In general thoroughly air-seasoned wood takes treatment better than green wood.

Mr. Dow: We find to the contrary. The United States Wood Preserving Company some time ago thought they had done a wise thing in purchasing a lot of seasoned timber, and they found it the very worst to treat.

Mr. Loud: It is the opinion of Dr. Allen, of Swarthmore, and also connected with the government service, that the real cause of the bleeding is the expansion of the air in the cells of the wood. In treating ties there is what is called the Rueping process, and in that the wood is subjected to pressure of 40 or 50 pounds, and while under that air pressure oil is run in, and a super-pressure up to 200 pounds is put on. That drives the already compressed air into the cells farther, and there compresses it with possibly 200 pounds per square inch. For 20-pound treatment you can put in 25 or 26 pounds of oil, and when the pressure is relieved, this air pushes the surplus oil out. An absolutely seasoned block has possibly 60 per cent. of voids in the wood, and those voids are full of air, and when the block is subjected to the rays of the sun on a hot summer day, that air is expanded, and forces out the oil, which has been made more fluid by the heat, exactly as it does in the Rueping process for treating ties. The reason why steaming and green material help the treatment is that water takes the place of the air in the cells, and you haven't the same power

to push the oil out. On our dock at Norfolk we have creosoted pine flooring, treated with ten pounds of oil, that has been down possibly four or five years. But with the hot summer's sun down there, these planks, although there is about an inch space between them, bleed every summer, and it is because the wood breathes in air, as the earth cools the air at night, and as it is hot in the daytime, it keeps forcing out the oil when it gets warmed up.

VITRIFIED BRICK STREET CONSTRUCTION.

By WILL P. BLAIR, *Cleveland, Ohio.*

Since the meeting of the Society last year, the writer has met with many experiences, found many conditions and observed many instances of practice in street and road building which created wonder and at times almost bewildered his mind. Perhaps many of you encountered like experiences but when relieved of the flurry of the immediate presence of such a state, you have been brought to a realization of a continued need that you and I and all who are battling for a better street and road condition in this country must relax in no wise of sacrifice and service for advancement all along the line from the most ignorant and unskilled as well as a better understanding and better application of scientific principles which underlie and assure the greatest efficiency in road building.

During the past season we have observed in two states that in repairing the chuck holes in an otherwise fairly good water-bound macadam road that the workmen under the direction of the official in charge were digging up the sod from the splendid roadside lawn and filling up the depressions with it. In a certain city where the complaint was almost universal against the repair department, the administration in repairing the cuts and openings in otherwise good grout filled brick streets by using brick of a different color than those used in the original construction and using in the patch a soft filler between the joints. Could such supervisory power be expected to accomplish anything but waste of money?

In many instances we have found no attempt whatever at compressing the fills; in other cases only single rolling was undertaken where the depths of the fill were from five to ten feet.

Fig. 1. Consistency of concrete required for best results.

In one instance we found that the engineer had designed a brick road providing for a crown fall of two inches in two feet and had actually let the contract involving such a design, calling for an expenditure of more than $40,000. These instances are merely noted as illustrations, they are neither rare nor exceptional. Similar ones can be recounted by the hundred, when you come into contact with the execution of carefully drawn specifications through the lack of skill, through unworthy motive, misinterpretation, ignorance or design, you seldom find the details of the specifications followed, though it be both economical and easy to do so. The dereliction if applied to a passenger train would soon wind up the railroad service in this country. The range of omission and commission in the execution of the work reaches from a momentary neglect to a stubborn resistance against complying with the specifications of the contract. The street thus suffers in worth, oft-times representing a loss in value from which contractor or no one else receives any advantage whatsoever. The loss is measured solely and only by the economic worth of the road itself.

The remedy for these things lies in removing the obstructions. It matters not whether it is a derelict contractor, an incompetent engineer or a worthless inspector. The value of efficiency must become more appreciated and any disposition that hinders and avoids must give way to healthy rivalry for excellence.

However disagreeable and discouraging these relative conditions are, is it becoming that we shall relinguish our efforts toward a better understanding and appreciation of the more refined details that have so much to do with the value, durability and satisfaction of a road? Shall we not become more familiar with the reason for details that conserve so much in the interest of the taxpayer and furnish him that which if he takes advantage, will result in the highest ideal in road construction? We must bear our share and even the much larger portion of it toward the eradication of these evils first men-

Fig 2. Thorough compression of sand cushion essential.

tioned; it rests with the public whether or not they enforce the suggestions given them for their benefit and welfare, and to establish a system of security for the best.

It is in connection with the latter subject that I wish to offer this paper, showing if possible the reasons for insistance upon some details in brick street construction which are not difficult to execute nor are they difficult to understand.

It is wholly upon us as students of road and street construction to furnish the best information our ability permits in scientific methods which result in the most satisfactory streets possible. To do this we must take into account all the varied demands of street service.

Satisfaction in use.

All elements of economy, comfort, and sanitation.

A smooth, uniformly compressed sub-base is a primary essential.

The necessity for a uniform support is apparent in the use of the street. It furnishes the element of economic proportions for the remaining superstructure.

Every practical precaution must be taken to preserve the sub-base in a continued dry state to a depth below the probable frost line—if there be no frost line, the requirement of drainage is not so essential, the reason for the drainage being, to provide against expansion and rupture which follows with low temperature if moisture is present. For the purpose of securing a dry condition of the sub-base, it is useless to drain with little fall or to carry any great distance a supply of water underneath the pavement. The water from underneath the pavement must be carried through transverse or triangular drains as quickly as the greatest fall practical will permit. From a slow-moving flow by capillary attraction the moisture is drawn up into the soil or earth and the drain is of no use whatever. The surplus water must be carried to points of disposal through tile side drains or sewers located as far distant from underneath the pavement and as far below the frost line as possible. Only in this manner is it possible to eliminate the

Fig. 8. A busy brick street on concrete foundation, eight years old.

injury to pavements due to low temperature and much of that due to high temperature. If the sub-base is dry, it furnishes a better support. If a concrete foundation is used, such drainage will prevent the intermittent wet and dry or contracting and expanding, that cracks and ruptures. During seasons of very high temperature, it takes away the hazard of a rupture from the expanding force of heat and steam. A crown in a street serves but one purpose—that of surface drainage. What little therefore is needed for that purpose had better be provided in the artificial foundation with a flat bottom and crowned top. The sub-base, once made, let it remain so. It should remain as a permanent and everlasting investment undisturbed, and not as is sometimes unfortunately the case, injured by hauling over it materials that go into other parts of the improvement. It is a crime to utterly destroy this part of the improvement before the public has any use of it whatever. For reasons given for a uniform sub-base corresponding with that of the finished street, the concrete base must be finished likewise. This is easily accomplished as illustrated by making the mix sufficiently wet to be spread with the back of a dirt shovel or a shovel made for the special purpose and slightly heavier. (See Fig. 1.) A guide template is greatly to be preferred over stakes to test the accuracy desired for a smooth grade and cross section. The proper application and function of the sand cushion overlying the foundation base seems to be little understood; many specifications do not require it to be rolled and when it is provided for, but little importance is attached to it. Two real fights between the contractor and the engineer and many disputes over the interpretation of the requirement for rolling and compression of the cushion took place in the presence of the writer this season. The sand cushion must be made to furnish a uniform and even support to the wearing plate of the brick that is to be built upon it. Its compaction and uniformity must be accomplished before the brick are placed upon it. It must be rolled, possibly dampened and re-rolled, struck off and re-rolled and depres-

Fig. 4. A good brick street in residential district on natural soil foundation, ten years old.

sions filled until it presents an approach to a solid or at least reducing to a minimum the voids in the sand. (See Fig. 2.) A mere smoothing of the top of the sand cushion affording a support here and there will not suffice nor will it do at all to depend upon compressing the cushion as an incident to rolling the brick. The attempt to roll the sand cushion transversely over the crown is almost fatal to good results.

It is unnecessary that the quality of the sand for this cushion should conform to either purity, sharpness, fineness or even freedom from soil. Uniformity in its character and freedom from refuse and pebbles is essential. Suitable sand for the cushion therefore is readily obtainable at reasonable cost in all parts of the country.

Whatever may be said of the durability of the brick in their service as a wearing surface, it is well to bear in mind that the entire preparation of sub-grade, foundation and all else ready for the reception of the brick by the exercise of care, both in the preparation of the specifications and in their execution, the work thus far may be regarded as a permanent part of the improvement. If proper care is exercised as to detail, it would be a most remote happening that any part of the work should sustain an injury and necessitate a repair in any way. It is highly important therefore and surely in the interest of economy that all details of the plan be carried out to the utmost and the plan itself be such as to include in it everything necessary.

It is well known that many things of a mechanical nature are only best done in one way. Certain it is that placing the brick on the sand cushion can only be done best in one way—the best edge must be uppermost.

The brick must be placed for the dropper or brick layer so that this result will follow as a matter of fact in the natural way of picking it up and dropping it in place. Someone else must place them in readiness for this operation and that duty must devolve upon the laborers who bring the brick to him from the pile along the street. The practice of first dropping

the brick into the street and depending afterwards upon taking them out and turning them over should no more be allowed than a mason in building a wall should first place a brick the wrong edge out for no apparent reason than to provide the necessity of relaying it. In street work, turning the brick disturbs the sand cushion and in wall work, the mortar bed is injured and in case of both, the value of the construction is greatly lessened.

The brick must be clean when placed in the street. I recently knew of a case where the contractor having been on his job almost daily, allowed his men to throw dirt during the excavation process upon the brick, disregarded the fact, and put the brick into the street unwashed. On the completion of the street, the contractor was so proud of it that he invited the writer to go over it with him to inspect it. It did look good and I did not have the courage to say to him that the bond would shatter and the street would be greatly marred in appearance and lesser value made apparent. In less than a year's time the bond of the cement filler was broken and the abutting property owners are contesting the pavement for the work. The contractor was one old in experience but he had not learned that a film of dirt will prevent the cement filler from adhering to the brick. It is needless to say that the neglect here lay equally upon both contractor and engineer. As a matter of economy, the brick should be placed at right angles with the curb line. I have no patience with the fancied theory that brick or stone lying in the street north, south, east or west or in picture form, adds or detracts to their wearing value. It is the physical advantage for resisting wear, impact and element of natural climatic effects that counts for economy in road construction.

It is doubtless expected that I should say something regarding the brick. I will say that the manufacturer of brick, who by trick, ignorantly or carelessly undertakes to put upon the public a quality of brick contrary to the obligations of his contract is entirely out of accord and out of sympathy with

the National Paving Brick Manufacturers' Association and of its officers.

In like manner we wish only fair dealing from our patrons. In the rarest instance have we found any dereliction during the past year on the part of the manufacturer. To the contrary, frequent losses have been sustained by incompetent inspectors and in many cases the best brick were among those

Fig. 5. Medina stone block pavement in southwest corner of Square at Cleveland, O., well laid in 1901. Note excellent condition.

rejected. We believe that plant inspection wherever practical will remedy much of evil existing in this respect and afford a greater protection to the public. It will reduce the number of inspectors and tend toward greater competency. Brick when placed in the street should be rolled to within a short space of the dropper as a matter of economical precaution as you can not roll them with the sand cushion saturated with water—a

contingency to be guarded against in a country subject to frequent rain falls. There must be no flow of sand up into the joints exceeding one-half inch from the effect of the rolling. If so, the sand cushion is not what it should be.

It does seem an easy matter to follow our well known directions for the application of the cement filler. The trouble does not lie with a lack of understanding or that it is difficult. Failures result from a disposition to do it some other way so that negative directions seem almost necessary as well as positive ones. The object of the filler is to unite the brick units and make the pavement monolithic and thus reduce the wear practically to one of friction and distribute the load to the widest area. It must therefore be hard, tough and adhesive and as nearly impervious as possible and of uniform strength. To secure these qualities we find:

The mixture must be one to one of fine sharp sand and the best quality of cement.

That it must be mixed and applied to maintain these proportions in place.

That it must be applied to a dampened brick surface to make it adhere.

That it must extend solidly throughout the entire interstices of the pavement.

It is impossible to call attention to all negative instructions or suggestions. Many things are done that ought not to be done which seem improbable. But a few days since, on a job where almost every step in construction approached the ideal, an intelligent appearing young man was found sprinkling the second coat of filler that had become slightly too stiff in shoving it forward in the second coat, washing off the cement coating from the sand particles instead of thinning by an intermixture of very thin consistency. A cement filler having been properly applied, do not expose it, do not allow it to be wrecked by an exposure to either extreme heat or violent changes of temperature. Cover it up and protect it so that in its setting, its maximum strength will result.

A brick pavement is no more difficult to properly build than an ordinary dirt or macadam road. Ordinary intelligence and a disposition to follow the lead as a good soldier have put into many hundred brick roads and streets all the directions necessary without any confusing experiments and such roads must be and are the ideals to inspire the healthy rivalry of road building.

Fig. 6. Medina stone block pavement on neighboring street to Fig. 5 badly laid and rapidly going from bad to worse.

It is not expected this paper will do more than indicate the best practice in brick street and road building. I nevertheless trust I have succeeded in directing your serious consideration to the importance of the subject. You may be able to further judge of this importance from the illustrations here given (Figs. 3 and 4.) The one is a busy street built upon a concrete foundation of six inches and bearing as heavy traffic

for eight years last past as can be found in our American cities of 200,000 population. The other, a street built upon the natural soil without an artificial foundation and bearing an average traffic in the residential district for ten years last past.

The importance of correct plans and proper execution of work where reasonable care has been exercised may be further appreciated from the results here given. In a large city where these factors obtain a most careful survey of 355 brick streets measuring a total length of 85.68 miles, and having an area of 1,204,955 square yards and bearing an age of from one to twenty-five years with an average life of fifteen years, ninety-nine per cent. of the area of these streets are in good condition and 75 per cent. of them are without an artificial foundation. Repairs from wear and tear have been so negligible that no accurate account is available but many of these streets have not been in need of any repair whatever and it is thoroughly believed that on many of these streets 95 per cent. of their area will not need any repair for many years to come.

We have undertaken to measure the economic value of roads and streets for many years by merely naming them by the kind of predominating material of which they are made. In view of our presentation, I am constrained to say that it is a waste of time to assemble data for economic value unless you take into account the manner and method by which the road is constructed. A comparison upon any other basis is without value.

Importance of accompanying data in measurement of the economy and value of a road with manner and method of its construction is illustrated by two pictures represented of roads of Medina stone block.

The one in the southwest corner of the square in Cleveland, Ohio, built in the most approved manner and method, the joints cement filled, in 1901, and subject to a very heavy traffic. This street is now easily cleaned, affording a sanitary condition at a maximum, traction resistance at a minimum, growing slightly better under use from year to year without

a penny expended for maintenance and repair, giving every evidence of like service for years to come.

The other, a nearby street in the same city, built of the same material, subject to less traffic, its condition most unsatisfactory in the extreme, the joints filled with a soft filler, not possible to maintain an even surface. It grows from bad to worse year by year, unfit to live near by, unfit for use, serving no good purpose for which a street is built, and entirely unsanitary.

Clearly we might be led to build our streets along a better and a more perfect line if the data which present information from which the value of a street becomes known, will be made to include the manner and method of construction of the street upon which the information is based.

Like comparisons can be made in the case of the brick streets here shown as against one where the manner and method of construction is ill-advised or carelessly and unskillfully built.

DISCUSSION.

MR. DRISCOLL: What was the foundation or soil in those 99 per cent. of streets that were in good condition, and where 75 per cent. had no artificial foundation?

MR. BLAIR: It was the natural soil found in those cities, sand, clay, gravel and sand, clay and gravel.

MR. F. A. SNYDER: What about the under-drainage? Also, I would like to know whether the pavement was subjected to frost?

MR. BLAIR: They were built in country where the frost goes into the ground something like three feet, but the drainage is good.

MR. SNYDER: What were they grouted with?

MR. BLAIR: With cement and sharp sand.

Fig. 4. A good brick street in residential district on natural soil foundation, ten years old.

sions filled until it presents an approach to a solid or at least reducing to a minimum the voids in the sand. (See Fig. 2.) A mere smoothing of the top of the sand cushion affording a support here and there will not suffice nor will it do at all to depend upon compressing the cushion as an incident to rolling the brick. The attempt to roll the sand cushion transversely over the crown is almost fatal to good results.

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THE EFFECT OF LEAKING ILLUMINATING GAS ON BITUMINOUS PAVEMENTS.

By GEORGE C. WARREN, *Boston, Mass.*

To everyone who has had long experience in bituminous pavement construction and maintenance, it is well known that illuminating gas escaping from sub-surface gas mains is very injurious to all forms of bituminous pavements, and yet we frequently find representatives of gas companies and city officials ridiculing the idea that gas can have any effect on such pavement surfaces.

The fact is that illuminating gas, a bituminous substance, and hydrocarbon quite similar in its chemical composition to light tar and oil distillates, is lighter and more penetrating than the distillates and even more rapidly attacks and liquifies a bituminous cement, no matter whether the bitumen be a tar or an asphaltic product.

EXPERIMENT NO. 1.

For testing the effect of illuminating gas on asphalt, there is submitted herewith a very simple apparatus and photograph thereof.

Photo No. 1.

Glass jar containing baskets of hard asphalt and sand asphalt mixture.

Photo taken at start of experiment, Aug. 18, 1914.

Illuminating gas entered at tube "C," filled the jar and passed out at tube "D" to a burner.

Gas passed through jar daily 8:00 A. M.-5:00 P. M. from Aug. 18, 1914, to Oct. 5, 1914, except Sundays and Labor Day, but naturally jar was filled with quiet gas during nights, Sundays and Labor Day.

The glass jar contains 2 baskets of No. 10 mesh screen.

Basket A contains 1-inch cube of hard California Refined Asphalt penetrating 20 degrees Dow.

Basket B contains 1-inch cube of mixture consisting of well graded sand 90 per cent.

California Asphaltic Cement (75 degrees Dow) 10 per cent.

A similar jar and contents which was not subjected to gas, has been kept alongside of the "gas jar" during the experiment to show that softening of material in the gas jar was due to gas and not change of temperature, is exhibited herewith. (See Photo No. 6.)

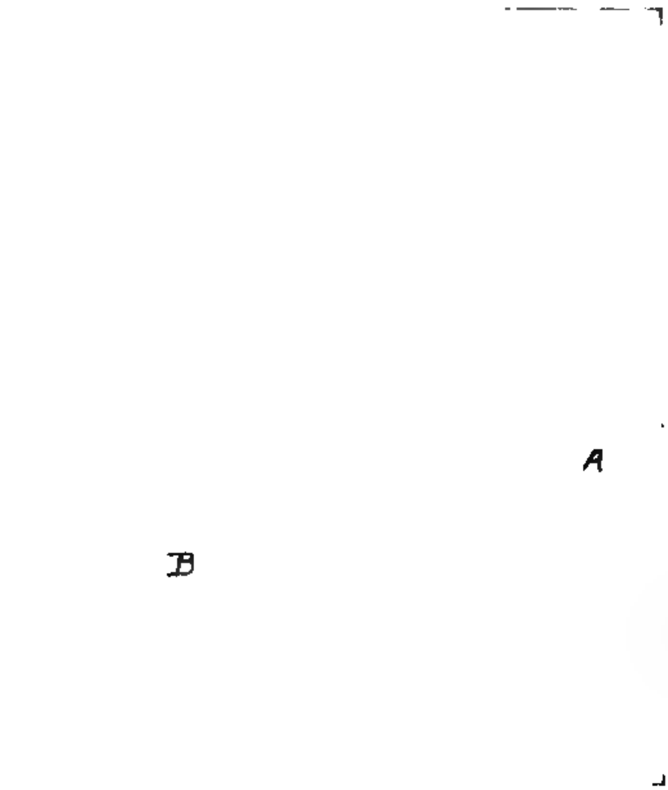


Photo 1. Glass jar containing baskets of hard asphalt and sand asphalt mixture.

Photo No. 2.
"Gas Jar" Sept. 3, 1914. After 15 Days' Exposure to Gas.
Photo No. 3.
"Gas Jar" Sept. 12, 1914, After 24 Days' Exposure to Gas.
Photo No. 4.
"Gas Jar" Sept. 16, 1914, After 28 Days' Exposure to Gas.
Photo No. 5.
"Gas Jar" Sept. 24, 1914, After 36 Days' Exposure to Gas.

Photo 3. Gas jar Sept. 12, 1914, after twenty-four days' exposure to gas.

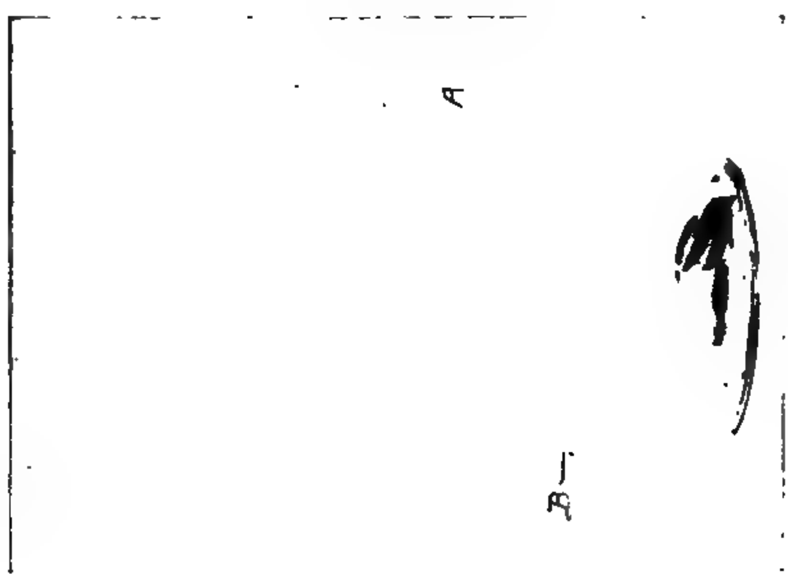


Photo 2. Gas jar Sept. 3, 1914, after fifteen days' exposure to gas.

Photo No. 6.

Jar containing baskets of hard asphalt and sand asphalt mixture same as in the jar shown in preceding photos. This jar was not subjected to gas but stood alongside of the other jar during entire experiment. Photo taken October 5, 1914.

Photos Nos. 2 to 5, inclusive, are the same jar as shown in Photo No. 1 taken during the test of six weeks on the following dates respectively—September 3rd, 12th, 16th and 24th.

Photo 6 shows that the softening was in no way due to change of temperature.

The daily diary of condition of asphalt and mixture is as follows:

Experiment started August 18, 1914.

		Asphalt Basket.	Mixture Basket.
Aug.	19 to 27	No noticeable change	No change except mixture glossy and sticky.
	28	Asphalt began to creep through, looking like small beads in the wire mesh.	Ditto above
	29	Ditto above.	Ditto above
	30	Gas turned off; Sunday; no observation.	Ditto above
	31	Outside of wire basket coated with asphalt which had crept through the mesh.	Ditto above
Sept.	1	Above condition slightly increased.	Ditto above
	2	Asphalt forming drop at bottom of basket.	Ditto above
	3	Asphalt increasing in softness; above drop has formed long pendant and small portion dropped to bottom of jar. See Photo No. 4.	Ditto above
	4	Ditto above; more drops.	Ditto above
	5	Ditto above; more drops.	
	6	Sunday; gas turned off; no observation.	Sunday
	7	Holiday; gas turned off; no observation.	Holiday
	8	3 distinct pendant drops of asphalt surface settled half way down basket.	Same as Sept. 5
	9	Same as above.	Same as Sept. 5
	10	Same as above.	Same as Sept. 5

11-28 Impossible to make intelligible diary, there being almost imperceptible changes from day to day. There has been, however, continuous but slow leakage of asphalt from the basket. The long pendant drop shown in photo No. 6 broke on Sept. 12th. A new drop started to form at that time and on Sept. 28 had reached about three-quarters the distance from basket to bottom of jar.

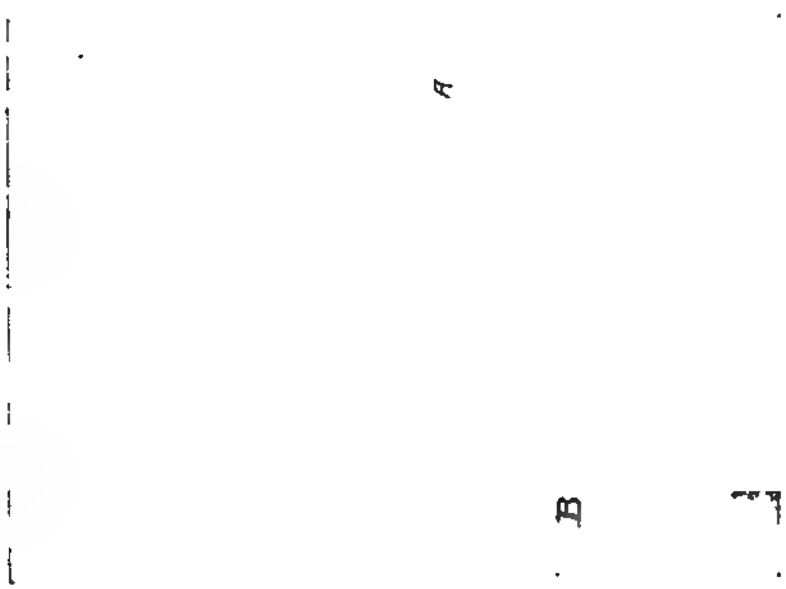


Photo 4. Gas jar Sept. 16, 1914, after twenty-eight days' exposure to gas.

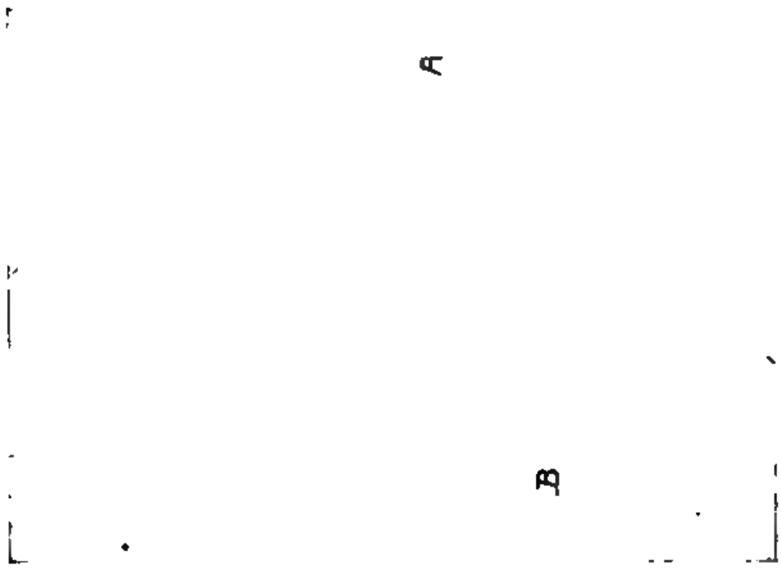


Photo 5. Gas jar Sept. 24, 1914, after thirty-six days' exposure to gas.

RESULTS OF EXPERIMENT No. 1.

	Mixture Basket	Refined Asp. Basket
Net weight material at start..................	17.90 grams	14.13 grams
Net weight material 9-28 (41 days)...........	18.04 grams	10.52 grams
Increase in weight........................... equals 0.78% of the mixture or 8% of the bitumen.	.14 grams	
Amount asphalt dripped from basket..........		3.61 grams
Amount asphalt dripped from basket..........		25.50%

The paving mixture of asphalt and sand has become reduced to the condition of a mixture of heavy oil and sand.

The foregoing experiment clearly proves the following fundamental facts:

A. That illuminating gas without agitation rapidly liquifies asphalt cement and refined asphalt and destroys its value as a cementing medium.

B. That illuminating gas not only attacks but combines with the asphalt, increasing its weight.

EXPERIMENT No. 2.

Commercial illuminating gas is very complex in composition and the portion which produces the luminous portion of the normal flame is very similar in composition to benzol, which when chemically pure is practically a perfect solvent for the bitumen which is the active component of all asphalts and coal tar pitches.

It is but natural then that when this gas comes in contact with any bituminous cement that more or less of the "illuminants" of the gas are absorbed by the bituminous cement and the candle power of the gas correspondingly reduced, and it is on account of this fact that the gas companies not only exercise the greatest possible care in cooling the gas to condense and separate out as completely as possible all oils and tars but also for many years, have insisted that all the cast iron pipes used as mains be coated with "asphalt dip" on the outside only, even though such pipe is more expensive.

In the ordinary process for the manufacture of coal gas the candle power is usually less than desired and the gas is usually

Photo 6 Jar containing baskets of hard asphalt and sand asphalt mixture same as in the jar shown in preceding photos. This jar was not subjected to gas, but stood alongside of the other jar during the entire experiment Photo taken Oct. 5, 1914.

Photo 7. Front side of apparatus entirely open, showing the burners and character of flames; on left showing brilliant flame of normal illuminating gas; on right showing darkened flames from gas which has passed through sand-asphalt mixture. Note the difference in the size of the blue portions of each flame and difference in brilliancy of the "halo" around each.

enriched by the addition of water gas, the latter being produced by the chemical combination of petroleum oil and steam under application of high heat.

It may not be generally known to those present, however, that in the absence of a carburetted water gas plant the most available method of enriching the gas is the direct addition of benzol vapor to not over 3 per cent.

In order to show the rapidity with which asphalt cement will absorb illuminants from gas, Experiment 2 is submitted herewith:

The apparatus is designed to show the comparative brilliancy of two flames of identical size, one burning normal gas which has passed through a glass tube containing dry sand; the other flame, burning gas which has passed through a corresponding ¾-inch tube 32 inches long containing a sand asphalt mixture. It will be noted that in the case of the normal flame the "blue" portion is very small and the flame luminous while in the other the "blue" portion of the flame is relatively much larger and the flame itself much lower candle power.

Photo No. 7.

Front side of apparatus entirely open showing the burners and character of flames. On left showing brilliant flame of normal illuminating gas. On right showing darkened flame from gas which has passed through sand asphalt mixture. Note the difference in the size of the "blue" portions of each flame and difference in brilliancy of the "halo" around each.

While this comparison can be plainly seen, as shown in photo 7, the contrast is more marked when the oiled paper screen is placed in front of the burners as shown in photo 8.

Photo No. 8.

Front side of apparatus closed by a translucent oiled paper screen showing at left side bright light from normal flame and at right darkened light from gas which has passed through sand asphalt mixture.

From the point of view opposite to Experiment No. 1, Experiment No. 2 proves the injurious effect on illuminating gas by contact with asphalt or other viscous bituminous material.

Photo 8. Front side of apparatus closed by a translucent oiled paper screen, showing at left side bright light from normal flame and at right darkened light from gas which has passed through sand-asphalt mixture.

Photo 9. Glass jar containing liquid California asphalt; gas entering at A and going out at B.

Experiment No. 3.

Having proved the effect on the bituminous cement and on the illuminating gas by their contact with each other, the next step in our experiments is to measure that effect on the bituminous material as a softening agent.

This experiment was made by filling a one-quart fruit jar about 6 inches deep with liquid asphalt of specific gravity of 1.0 on afternoon of September 18th. It is necessary in carrying out this test to employ liquid asphalt and also to apply the gas under higher pressure than is on the ordinary gas burner, in order that the gas may pass freely through the asphalt.

Two tubes were inserted; one for inlet of gas extending to bottom of jar, the outlet tube being of course above the surface of the asphalt with a burner at top of tube. With the exception of Sundays, September 20th and 27th, gas has been passing through this asphalt and burned at outlet.

Photo No. 9.

Glass Jar Containing Liquid California Asphalt. Gas Entering at "A" and Out at "B."

After 12 days' exposure to gas the asphalt had increased 2.96 per cent. by weight and 4 per cent. in volume.

The comparative characteristics of this liquid asphalt before and after the above exposure to gas, are as follows:

	Before	After
Specific gravity at 60° F.	1.00	0.99
Flash Point	190° F.	120° F.
Engler Viscosity		
1st 50 c.c.	155 sec.	75 sec.
2nd 50 c.c.	170 sec.	90 sec.
Weight	955.1 grams	983.6 grams
Increase of weight		2.96%
Volume	955.1 c.c.	993.5 c.c.
Increase in volume		4%

It may be well to here state that while asphalt and sand mixtures are used in making these tests, being more convenient for small experiments than coarser bituminous mixtures, it is not intended to claim that one bituminous paving mixture

is more readily affected by gas exposure than another, and more particularly it is not claimed that the particular form of bituminous pavement surface in which the writer is most commercially interested is affected to any less degree than other bituminous mixtures.

The foregoing is of practical as well as scientific interest and believed to be worthy of record in the proceedings of this Society. To us as practical road engineers and road builders, however, the important question is the title of this paper: "The Effect of Leaking Illuminating Gas on Bituminous Pavements" and "What are we going to do about it?"

In my thirty years of experience with asphalt and other bituminous pavement construction, this matter has come up many times, and generally the persistent claim of the gas companies is:

1. That it is ridiculous to suppose that gas will attack an asphalt pavement.

2. That the gas mains have been carefully tested by plugging holes through the pavement and into the ground and that there are no leaks.

3. When the main is on the side of the street opposite a portion of the street affected, it is too far away.

I would comment on these points as follows:

1. There can be no question but that coal gas, being a hydro-carbon in gaseous, and therefore its most penetrating form, will attack any form of bitumen even more rapidly than oil, just as gasoline, being more penetrating, will attack bitumen more rapidly than heavier oil, such as machine oil, for instance.

I particularly remember one extremely aggravated case on West End avenue, New York City, about fifteen years ago, which became re-affected, and the asphalt pavement again ruined within three months after it was resurfaced, the Gas Company having claimed that they had thoroughly tested the mains and repaired the leaks. Shortly subsequent to this, the

Gas Company was obliged to entirely relay the gas main and the pavement was again relaid.

2. Even if they dislike to, or will not admit it, the gas companies well know that the "plugging" test only *sometimes* locates the leaks. They naturally dislike to go to the expense of tearing up and relaying pavements and excavating to and uncovering the mains, unless the conditions become such that they are absolutely required to do so.

3. The leaking gas naturally follows the lines of least resistance which may be in either a nearly vertical line and show the result almost immediately above the leak, or what is extremely hard to find, may follow a long distance through a vein of porous earth or along the space formed by some old settled trench and reach the pavement surface a long distance from the leak. In such cases the pavement is generally affected over a large area, because the earth has become quite generally saturated with the gas, which gradually works up to the pavement surface.

I remember a case in about 1888 on Rutger street, Utica, N. Y., where the first indication of trouble in the gas main was the effect on the asphalt pavement. The gas company claimed they had repaired the leak and a considerable area of pavement was relaid. About a month later an elderly couple, while asleep in one of the residences nearly a block away, were nearly asphyxiated by gas leaking from the street. Probably the gas had first found a partial outlet, following along a vacancy in some trench settlement, and then through the pavement. Subsequently the leak became worse, with the serious result referred to above.

Frequently, if not generally, the first indication of leak in the gas main where the street has a bitumen pavement, is the effect on the pavement, in which case it is good fortune that the pavement is of a character which is affected by gas and will permit the gas to permeate the surface, thus lessening the chance of serious casualty as above outlined in Utica.

The visible effect of leaking gas on a bituminous pavement is a serious "shifting" or "rolling" of the pavement in its softened condition, accompanied by a breaking up of the surface into a "crackled" appearance not unlike the folds or cracks in an alligator's back.

Generally when this condition is noticed, a perceptible odor of gas will be found in the pavement surface, but sometimes the leak may have been repaired or the gas taken another course and the gas escaped so that its odor cannot be detected, yet the pavement is left in a seriously damaged condition. On the other hand, under certain subsoil conditions, the earth below the pavement may retain the escaped gas and continue to have its damaging effect for months, if not years after the gas main has been repaired, and the cause of the trouble probably removed.

The effect on the pavement may extend for a considerable period beyond the repairs to the gas main, unless steps are taken to provide frequent vents left open for several days if not weeks after repairs to the gas mains are made.

In such cases, before making repairs to the pavement, its entire surface over the main and where the surface shows the effect of gas, should be removed and the gas main should be thoroughly repaired (renewed if necessary). After the leaks are repaired, vents or openings at least one foot square, extending from the surface to the level of the gas main, should be left open for two or three weeks or longer, if there is still any odor of gas, and the openings then refilled and *thoroughly tamped* and the pavement surface relaid. With this precaution the trouble will probably be overcome if the gas company has not been too parsimonious, inefficient or incomplete in making of repairs to the gas mains.

In conclusion, it may be well to call attention to a pernicious but quite general custom of the gas companies in their "hunt" for leaks. I refer to the custom of having two or three men, one of them selected for his "smelling" efficiency, go along the street, where there are indications of gas leaks, ham-

mering a cone shaped bar through the pavement into the ground below. These holes are made at intervals of a few feet. The "smeller" man puts his nose to the holes and if he discovers a sufficient odor of gas to attract his attention, an opening is dug to try to discover the leak. If the "smell" test does not locate a leak apparently below the hole, it is quietly filled with dirt. A few weeks later the city official, or the "poor devil" of a paving contractor, if he happens to have the pavement under "guaranty," finds serious holes along the center line of the pavement and not being able to trace the trouble to any cause, he makes the repair, if his "guaranty" is good, or "lets it slide" if he and his "guáranty" are no good, and perhaps at the end of a law suit the city makes the repairs. The simple, but so far as the writer knows never enacted, cure for this evil is an ordinance requiring gas companies, whenever they want to test their mains, to cut openings of sufficient size through the pavement to enable excavation to the gas main, absolutely prohibiting the promiscuous drilling holes through the pavement as above described and to pay for making a proper repair to the pavement. With the enactment and enforcement of such ordinances the chances of locating the leaks are greatly increased and the unfairness to the city and contractor of making holes in the pavement without adequately repairing them will be eliminated.

EFFECT OF ILLUMINATING GAS ON BITUMENS.

Discussion by S. R. CHURCH *of Preceding Paper by Geo. C. Warren.*

The destructive effect upon bitumens of illuminating gas, and also of the liquid that condenses from illuminating gas in the holders and mains was first called to my attention during 1907, in connection with an investigation of the comparative value of various bitumens for waterproofing underground structures. At that time I conducted a number of laboratory tests along lines very similar to those described by Mr. Warren, and found, as he has found, that in an atmosphere of illuminating gas, bitumens are softened very appreciably. I also found that the solvent action of the gas condensate, commonly known as "gas drips," on the bitumen, was very marked.

More recently, we have undertaken an investigation of the physical and chemical characteristics of a wide range of bitumens, including asphalts and tar pitches. That portion of the investigation dealing with the effect of illuminating gas on bitumens was conducted as follows:

Accurately weighed quantities of the bituminous material were placed in ordinary porcelain combustion boats; were exposed to the effect of a stream of illuminating gas flowing at a rate of 3.5 cubic feet per hour for six days. The tests were carried out in specially constructed iron tubes in which a temperature of 15 degrees C. was maintained by means of a water jacket, and a burner controlled by a metallic regulator. The flow of illuminating gas was regulated by meter control, and by having the gas pass through a definite opening of 1/64 inch diameter. At the end of the test the boats were removed, weighed, and the bitumen removed from the boats, run into small metal containers, and penetration at 77 degrees F. de-

Front view of apparatus used to expose asphalt samples to stream of illuminating gas in the tubes shown projecting from the end of the water-jacket heated by gas burners below.

Rear view of same apparatus showing gas connections.

termined for comparison with the original penetration test of the bitumen.

The bitumens tested all showed increases in weight, varying from .1 to 4 per cent. As Mr. Warren has only given the results of his tests on one particular type of bitumen, I will not enter into a discussion of the comparative results at this time, except to say that bitumens vary greatly in their susceptibility to illuminating gas. However, as stated by Mr. Warren, they are all affected by it, and almost all of them show measurable increases in penetration. In some cases this increase in penetration was as much as 60 degrees Dow.

The solvent action of gas drip on bitumens was determined by carefully preparing films of uniform thickness, and measuring the time required for gas drip under a definite head to penetrate through the films. I will not discuss the details of this test at present, except to say that here also the bitumens were all affected, but some failed much more rapidly than others.

We expect to publish the results of our investigations before very long, and hope that a consideration of the results will lead others to undertake a study of the comparative resistance of different bitumens to the effect of gas. As Mr. Warren has pointed out, this is a very important matter, and sufficient attention has not been given to it.

NAPPED, RE-CLIPPED GRANITE PAVEMENT. A GOOD METHOD OF UTILIZING WASTE MATERIAL.

By Wm. A. Howell, *Newark, N. J.*

Until recent years old granite blocks were not supposed to have any great commercial value. They were principally used for paving the yards of freight terminals and the tracks of street railway corporations, stock yards, etc. There was no regular demand for this form of paving material. In May, 1911, the City of Newark received bids for the repaving of a very important thoroughfare, calling for 23,500 square yards of pavement. A smooth pavement was to be laid, and the contract provided that the old granite blocks taken from the old pavement should become the property of the contractor, and that allowance for same should be made in his bid for the new pavement. The successful bidder was not particularly pleased with this provision of the contract and made the remark that he expected to have the old blocks on his hands about ten years. At this time we are replacing an old granite pavement on Broad Street, Newark, with a four-inch wood block pavement. The yardage of the old pavement was 75,500 square yards, the number of paving blocks in the street aggregating 1,585,500 blocks, of which probably 85 per cent are usable. The city is selling these blocks to contractors on napped granite work at \$30.00 per thousand. The blocks represent an asset to the city of about \$40,000.00, a very tidy sum for the street repair fund. The writer inspected a number of granite quarries in Maine and Massachusetts in the summer of 1909, and was accompanied throughout a portion of the trip by the owner of a large quarry in Maine, who was also a paving contractor in New York City and adjoining towns. The granite man was asked the question: "To what use can old granite blocks be put?"

His answer was that "they could be napped and reclipped and would practically make a new pavement. The first street within our knowledge where napped or recut granite blocks were used for the paving material was on Webster Avenue in the Borough of the Bronx in 1909. The old blocks were 7 and 8 inches in thickness and with few exceptions in fair condition, coming principally from Long Cove, Me., Cape Ann, Mass., and Somes Sound. The specifications called for the blocks to be 6 to 12 inches long, 3½ to 4½ inches wide and 5½ to 6½ inches deep. Where a block ran up to 4¾ or even 5 inches wide, the Engineering Department allowed it to be laid, provided the entire course was carried out with blocks having the same width. The price bid was $1.27 per square yard for the paving and $4.00 per cubic yard for the concrete, 5-inch concrete being used. The specifications originally provided for the joints to be filled with fine gravel and paving pitch. After the work had been started it was deemed advisable to substitute cement grout. There may have been some small jobs of napped, reclipped granite work done before the work referred to, but to the best of our knowledge, this is the first contract work awarded by a municipality, laid with this form of pavement. The street referred to is in first class condition today. Since that date the Bronx authorities have laid thousands of yards of this form of pavement, mention of which will be made later on. "The old blocks (in the words of the contractor, Mr. William Booth) were simply napped and squared up to give a joint say not exceeding ¾ of an inch. The price paid for making these blocks was $10.00 per thousand."

Mr. William H. Connell, Chief of Bureau of Highways, Department of Public Works, Philadelphia, has informed the writer they have only one street laid with napped, reclipped grouted granite blocks, and that is Broad Street, between Cumberland Street and Silver Street, a distance of about 1,450 feet and a yardage of 10,546 square yards. This was a repaving job, the old blocks being taken up, reclipped on the job and replaced in the street. The cost was $1.43 per square

yard, which included the cost of the sand cushion. The concrete base was in place. The specifications called for the blocks to be redressed to the following dimensions: Five (5) to six (6) inches deep, five (5) to seven (7) inches long, and three and one-half (3½) to five (5) inches wide. "Of course, it is necessary (in the words of the specifications) that the blocks shall not be too badly worn to be clipped in such a manner that they will comply with the specifications and blocks differing in width more than one-quarter of an inch will not be allowed." This pavement was completed in June, 1913. Mr. Connell states that in his judgment "the laying of this kind of pavement is very economical, as it equals in smoothness and appearance, the latest, and best type of construction, of granite block paving." The writer inspected this street during July of the present year, and was greatly pleased with its appearance. The heads of the blocks were remarkably smooth, and the joints appeared to be closer than could be obtained on the majority of streets laid with new granite.

Mr. A. E. Roche, City Engineer of Troy, N .Y., has written the author of this paper as follows: "During the past year the City of Troy has gone into the splitting and quartering of its old granite block pavements and relaying them, on quite an extensive basis. The streets on which the blocks were halved and quartered, or napped and reclipped (as it is called in Newark) were paved some thirty or forty years ago with Rockport Granite of a size 9 to 14 inches long, 5 to 6 inches in width, and 7 to 8 inches in depth. These granite blocks naturally became rounded on the surface and very uneven. The streets particularly referred to are adjacent to the Boston and Maine Freight Terminal, and to the New York Central yards. The successful bidder was required to take up the blocks, remove them from the site of the street to any plot of ground he could hire, for the purpose of napping and reclipping, to excavate the gravel foundation on which they had been originally placed, to a depth of approximately 4 inches, and to lay a concrete foundation of an aggregate of one part

of cement, three parts of sand and six parts of stone. The blocks were then halved and quartered, so that they were from 7 to 9 inches long, 4 to 5 inches in width and 4 to 5 inches in depth; then hauled on the street, laid on a sand cushion and grouted with a cement filler, mixed in the proportion of one part of cement to one part of sand. In the laying of the blocks particular attention was given to the necessity of having a new surface always on top, so that the cement filler readily adhered to the joints as well as to the surface. This work was done entirely by contract, at a unit price of $2.30 per square yard, including excavation, concrete foundation, maintenance, and guarantee for a period of five years. On the street on which the local street railway company maintained tracks, a price of $2.40 per square yard was paid for the same depth of excavation and concrete foundation. The city required the contractor to split the entire number of granite blocks on the street, although we knew that an excess of about 25 per cent first class blocks would be obtained over and above that required. For this excess of split blocks the contractor was allowed $15.00 per thousand, delivered to the City Engineer at such points as he directed within a radius of one-half mile from the place of cutting. The total amount expended this year for napped and reclipped blocks has been $62,000.00. The City of Troy had previously been paying an average price of $3.85 per square yard for close jointed 4-inch Concord, New Hampshire, granite block pavements. We consider this price fair when one considers that we have never been called upon to expend anything for the upkeep and maintenance of streets on which this type of pavement was laid, although it has now been down about eight years. The city has in view for next year about 22,000 square yards of old granite blocks, which we propose to halve and quarter, rather than discard for new blocks."

Mr. H. H. Schmidt, Chief Engineer, Bureau of Highways, Borough of Brooklyn, informs the writer that in his city "we have not used what is commonly known as 'napped blocks'."

In Brooklyn they have paved a number of streets with a re-cut granite block, made from the old large stone, but redressed to a regular specification size. The name of the streets thus paved, yardage, prices, etc., is given below:

Streets and Limits	Total Yardage	Price of Granite sq. yd.	Price sq. yd. incl. con	Joint Filler	Remarks
(1) Dunham Pl., So. Sixth St., Broadway	801	$2.75	$3.66	Cement grout	No RR
(2) Morgan Ave., Meserole, Johnson Ave...	2162	2.67	3.50	Cement grout	RR
(3) First St., Bond St., Gowanus Canal.....	1534	2.50	3.42	Cement grout	No RR
(4) Third Ave., Dean, Union Sts..........	5450	2.59	3.55	Tar and Gravel	RR
(5) Third Ave., Union, Hamilton Aves......	16033	3.12	4.10	Tar and Gravel	RR
(6) Ninth St., Gowanus Canal, Third Ave....	3985	2.31	3.14	Cement grout	RR

All of the above are laid on a 6-inch base.

(5) Finished early this year; (4) finished 1913; the others during 1912.

The writer has information from Mr. W. H. Durham, Chief Engineer, Bureau of Highways, Manhattan Borough, that no reclipped granite block pavements have been laid in that borough until very recently. A contract has just been completed for the paving of three blocks on Avenue A from 54th Street to 57th Street, or about 5,500 square yards of reclipped granite blocks, using the old material found on the street, the blocks being broken in two and laid with the fractured side as the head, with one-inch sand cushion. Of the total, 1,830 square yards were filled with standard tar filler and 3,670 square yards were cement grouted. This was done for purposes of comparison. The contract costs were, for wearing surface, $1.45 per square yard, and for concrete $5.00 per cubic yard. The pavement has but recently been opened to traffic, so that no statement can be given as to its value from a surface standpoint. It should be noted that the old blocks were adequate to fur-

nish material for only about 60 per cent of the total area, the remainder having to be supplied with new material by the contractor.

The City of Trenton, N. J., has recently laid about 3,500 square yards of this form of pavement, using cement grout for filler, the blocks being furnished by the city, the contract price per yard on 5 inches of concrete was $1.58. As stated in the beginning of this paper, the credit of introducing this form of pavement, belongs to the Borough of the Bronx. Mr. Richard H. Gillespie, Chief Engineer of Sewers and Highways of the Borough, has given the writer much valuable information, relative to the laying of napped, reclipped granite in the Bronx. The list of streets given below, covers only the principal streets. A large number of streets have been paved, involving in each case, a comparatively small yardage, which Mr. Gillespie did not desire to furnish, thinking it would make the list too cumbersome.

	Yardage	Cost per yard exclusive of concrete foundation	Date of completion
Webster Ave., from 165th to 171st St.	20,227	1.27	September, 1909
Melrose Ave., from E. 149th St., to E. 163 St., together with a number of intersecting streets	32,255	1.38	November, 1910.
Third Ave., from 150th St. to 177th St.	71,370	1.19¼	November, 1912
Southern Boulevard, from Willis Ave. to 138th St.	26,670	1.05	November, 1912
Brook Ave., from 156th St. to 3rd Ave.	6,720	1.17	October, 1913
Webster Ave., from 178 St. to 187th St.	24,902	1.22	December, 1913
169th St., from Boston Road to 167th St., and 167th St., from 169th St., to Southern Boulevard	7,497	1.27	June, 1914
Tremont Ave., from 3rd Ave. to Boston Road	23,700	1.53	August, 1914

In each case, the price per square yard of pavement, is exclusive of the cost of the concrete foundation, but includes the cost of napping, or redressing the blocks, the sand cushion, laying grouting, etc. The high cost per square yard, of the

pavement, laid on Tremont avenue, is accounted for, by the fact, that a number of the old blocks were very poor, so that it was apparent, when bids were received, there would be a deficiency of material, which would have to be supplied by the contractor with new blocks. The thickness of the foundation, under this type of pavement, was five inches, on that laid prior to 1912. All the later pavements have been laid with a six inch, 1-3-6 concrete foundation. The cost per cubic yard for the concrete has averaged on the pavements above listed $4.20 per cubic yard. The blocks laid on sand, under the old specifications, are in most cases fully up to the length specified, in, fact, a considerable proportion run from 12 to 14 inches in length, and are rarely less than 7 inches in depth. The splitting, and dressing, consists in breaking in two the blocks, running in length, from 11 inches up, using the broken surface as the head, and dressing the ends and sides to lay ½-inch joints. The finished blocks are from 6½ inches to 8 inches long, 3½ to 4½ inches wide, and from 5½ to 6½ inches deep. Blocks shorter in length than 11 inches are re-headed where necessary, dressed to lay the required joints, and as a rule, are used along the street railway tracks. The splitting and dressing is done on the streets by cutters who receive about 1½ cents for each redressed block, each man getting out from 450 to 600 blocks per 8-hour day, depending partly on his skill and speed, and partly on the character of the granite and the condition of the blocks. As the blocks are dressed they are piled along the sidewalk until the concrete is in readiness for the pavement. The blocks are laid in the usual manner in rows at right angles to the curb line, on a 6-inch 1-3-6 concrete foundation with a 1½-inch sand cushion. Up to November, 1913, 267,150 square yards (or 7.96 miles) of this type of pavement had been laid in the Borough of the Bronx, all of it with vertical joints, filled with Portland cement grout, at an average cost of $1.21 per square yard, exclusive of the concrete base, as compared with an average cost of $3.20 per square yard, for new improved granite block, exclusive of foundation.

Mr. Frank R. Lanagan, City Engineer of Albany, N. Y., states in his city "they are taking up the old granite blocks on many streets, breaking them in half, redressing the sides when necessary, relaying the broken blocks with the new surface up on a 6-inch 1-3-6 concrete base and grouting the joints with a one to one grout. The old blocks vary in size and form, and from many old blocks but one new block can be obtained. There is as a general rule, some surplus for a given area." (The specifications as to size have been quoted in another portion of this paper.) The contract prices for this work vary according to locality and yardage. The price per square yard includes taking up the old blocks, breaking and redressing the old block, a new 6-inch 1-3-6 concrete foundation, sand cushion of 1½ inches, laying and ramming the redressed blocks, grouting with a one to one grout and five years' maintenance. The prices per square yard on various contracts have been:

6,000	square yards at	$2.19
3,200	square yards at	2.21
3,400	square yards at	2.76
3,300	square yards at	2.35
16,900	square yards at	2.24

The Albany specifications, which are also used in Schenectady, contain the following interesting features: "The old granite block pavement now on the street shall be taken up, removed from the limits of the street, broken in half and redressed, returned to the street and relaid on a new concrete foundation with the joints grouted. Each old block if of sufficient size and of good quality shall be broken in half and redressed. The broken block shall each measure after recutting not less than six inches in length, not less than three and one-half (3½) inches, nor more than four and one-half (4½) inches in width, and not less than five (5) inches nor more than six (6) inches in depth. Blocks less than 10 inches in length shall be dressed to conform to the above dimensions. Any stones which are soft, brittle or laminated, or which in redressing develop any imperfections, will be re-

jected. The Commissioner of Public Works will supply in the number of old granite blocks required to repave the street, the contractor, however, doing the necessary carting.

"*Paving.* The old granite blocks which have been broken in half and redressed, conforming to the dimensions stated above shall be distributed along the street just in advance of the paving. Said stones shall be placed in such position and location and the carriage way shall be formed in such manner as to make the most substantial and durable pavement. Each course of blocks shall be of uniform width and so laid that all longitudinal joints shall be broken by a lap of at least two inches and all side and end joints must not exceed three-quarters of an inch. The old blocks shall be paved as far as possible with the new faces up. If there is any difference in the width of the upper and lower faces of a block, the wider face must always be placed below. The block shall be laid with their longest dimension perpendicular to the center line of the street and upon straight lines across the carriageway."

The Town of Kearney, N. J. (across the river from Newark), laid in the summer of 1913 a napped, reclipped granite block pavement on Tappan Street, between Davis Street and Chestnut Street. The old blocks came from the old blocks taken up from Market Street, Newark. The length of the improvement was 983 feet, the yardage 3,278 square yards, and the contract price per square yard of pavement, including the 6-inch concrete foundation, was $2.48.

Information has been received from the City of Baltimore through Mr. R. Keith Compton, Chairman and Consulting Engineer to the Paving Commission, that Baltimore has taken up napped granite paving and adopted it as a regular part of the annual municipal paving program. Mr. Compton informs the writer that the napped, reclipped granite paving work was started in 1913, when the following yardage was laid:

1913.

Bituminous filled, on a 6-inch concrete base.................5,010 sq. yds.

Average cost per square yard, including recutting, laying, sand cushion, joint filler and concrete base:

City area	2.58
*Railway area	2.23

The fact that the railroad area is so much lower in price than the city area, is that this $2.23 was an unbalanced bid, and can hardly be considered fair, as the railway area price generally runs about ten (10) cents more than the city area.

1914.

Cement filled, on a 6-inch concrete base	20,100 sq. yds.
Bituminous filled, on a 6-inch concrete base	7,692 sq. yds.
	27,792 sq. yds.

Average prices:

Cement filler, city area, including recutting, laying, sand cushion, filler and concrete base	$2.52 per sq. yd.
*Cement filler, railway area, including above items	2.45 per sq. yd.
Bituminous filler, city area, including recutting, laying, sand cushion, filler and concrete base	2.63 per sq. yd.
Bituminous filler, railway area, including above items	2.78 per sq. yd.

*Note—Also indicates an unbalanced bid.

The City of Baltimore intends doing a great deal of this form of granite paving during 1915.

The first attempt at the napped, reclipped granite work in Newark was made with the paving of a portion of Meeker Avenue, extending from Frelinghuysen Avenue to Western Avenue. The contractor did not pay enough money to get good results and in addition to this his supply of reclipped blocks came from many different streets, representing the original output of different quarries. It was only after the expenditure of much time and patience that the pavement was finally accepted by the city. The work awarded during the present year represents the paving of six streets and the repaving of three other streets, representing a yardage of 26,900 square yards and an estimated cost of $94,337.45. A portion of this

work has already been completed and gives general satisfaction. The various contractors have at their command the blocks from the old Broad Street paving now being replaced with wood block, and the smooth heads of the reclipped blocks and the close joints are very noticeable even by ordinary observers. Extending from Washington Street to High Street, between William Street and Clinton Avenue, are located a number of streets which until very recently were paved with cobble. Of the streets referred to, Spruce Street, Crawford Street, and East Kinney Street have been paved with new grouted granite blocks, and Baldwin Street, Longworth Street and Court Street, have been paved with the napped, reclipped variety. The latter compare very favorably with the former and cost about 60 cents per yard less. The city has under consideration the repaving of three very important streets with the napped blocks, the intention being in each instance to use as much of the old granite paving material in the present pavement as conditions will warrant. The streets referred to are Ferry Street, from Market Street to Lentz Avenue, carrying a yardage of 21,000 square yards; Washington Street, from Market Street to Central Avenue, 6,400 square yards, and Plane Street, from Market Street to State Street, 14,800 square yards. The estimated cost of repaving these streets, with the napper material, is $72,000 for Ferry Street, $17,600 for Washington Street, and $39,000 for Plane Street. As these contemplated improvements involve a bond issue it is extremely doubtful at this time that they will be carried out. The old blocks used on the 1914 jobs in Newark range in length from 10 to 14 inches. A blockmaker can in a day's work of eight hours nap and reclip 175 large blocks into 350 small ones. It costs the contractor $15.00 per thousand for the small blocks, or $30.00 per thousand for the large ones. These blocks run 21 to the yard, or 42 to the yard for the small ones. A rough detailed estimate of the cost of this kind of pavement, which would permit of a variation of possibly 10 to 15 cents, would be about as follows:

contingency to be guarded against in a country subject to frequent rain falls. There must be no flow of sand up into the joints exceeding one-half inch from the effect of the rolling. If so, the sand cushion is not what it should be.

It does seem an easy matter to follow our well known directions for the application of the cement filler. The trouble does not lie with a lack of understanding or that it is difficult. Failures result from a disposition to do it some other way so that negative directions seem almost necessary as well as positive ones. The object of the filler is to unite the brick units and make the pavement monolithic and thus reduce the wear practically to one of friction and distribute the load to the widest area. It must therefore be hard, tough and adhesive and as nearly impervious as possible and of uniform strength. To secure these qualities we find:

The mixture must be one to one of fine sharp sand and the best quality of cement.

That it must be mixed and applied to maintain these proportions in place.

That it must be applied to a dampened brick surface to make it adhere.

That it must extend solidly throughout the entire interstices of the pavement.

It is impossible to call attention to all negative instructions or suggestions. Many things are done that ought not to be done which seem improbable. But a few days since, on a job where almost every step in construction approached the ideal, an intelligent appearing young man was found sprinkling the second coat of filler that had become slightly too stiff in shoving it forward in the second coat, washing off the cement coating from the sand particles instead of thinning by an intermixture of very thin consistency. A cement filler having been properly applied, do not expose it, do not allow it to be wrecked by an exposure to either extreme heat or violent changes of temperature. Cover it up and protect it so that in its setting, its maximum strength will result.

NAPPED, RE-CLIPPED GROUTED GRANITE PAVEMENTS, NEWARK, N. J.

Name of Street	Square Yards	Name of Contractor	Date of Award	Contract Price Per Sq. Yd.	Estimated Cost of Improvement	Remarks
Meeker Avenue	1,700	Martin J. Egan	May 2, 1913	$2.40	$4,362.50	
Warren Street	3,900	Ralph Sangiovanni	May 2, 1913	2.50	11,607.50	
Duryee Street	4.600	O'Gara & McGuire	May 14, 1914	2.63	15,575.00	
Court Street	3,500	Pasquale Cestone	June 4, 1914	1.77	9,250.00	Old blocks from former pavement used
Jabez Street	4,000	Jackson Contracting Co.	May 14, 1914	2.49	21,606.75	
Jelliff Avenue	4,000	O'Gara & McGuire	May 14, 1914	2.49	12,416.80	
Baldwin Street	3,200	O'Gara & McGuire	May 14, 1914	2.49	10,217 90	
Longworth Street	3,000	O'Gara & McGuire	May 14, 1914	2.49	9,523.00	
Lackawanna Ave., North	2,750	Ralph Sangiovanni	June 4, 1914	2.73	9,127.00	
Lackawanna Ave., South	1,600	Martin J. Egan	June 4, 1914	2.69	5,703.00	
Orange Street	250	Ralph Sangiovanni	June 4, 1914	2.85	918.00	
Total	32,500				$110,307.45	

Average cost per square yard, where blocks were not taken from the old pavement, $2.54½.
Average cost per square yard, where the granite blocks in the old pavement were napped and used over again, $1.77.

NAPPED, RE-CLIPPED, GROUTED GRANITE PAVEMENTS, NEWARK, N. J.

Name of Street	Sq. Yds.	Name of Contractor	Date of Award	Contract Price Per Sq. Yd.	Estimated Cost of Improvement	Remarks
Duryee St.	4,600	O'Gara & McGuire	May 14, 1914	$2.63	$15,575.00	
Court St.	3,500	Pasquale Cestone	June 4, 1914	1.77	9,250.09	Old blocks used in the old pavement
Jabez St.	4,000	Jackson Cont. Co.	May 14, 1914	2.49	21,606.75	
Jelliff Ave.	4,000	O'Gara & McGuire	May 14, 1914	2.49	12,416.80	
Baldwin St.	3,200	O'Gara & McGuire	May 14, 1914	2.49	10,217.90	
Longworth St.	3,000	O'Gara & McGuire	May 14, 1914	2.49	9,523.00	
Lackawanna Ave. North	2,750	Ralph Sangiovanni	June 4, 1914	2.73	9,127.00	
Lackawanna Ave. South	1,600	Martin J. Egan	June 4, 1914	2.69	5,703.00	
Orange St.	250	Ralph Sangiovanni	June 4, 1914	2.85	918.00	
Warren St.	3,900	Ralph Sangiovanni	May 2, 1913	2.50	11,607.50	
Wheeler Ave.	1,700	Martin J. Egan	May 2, 1913	2.40	4,362.50	
	32,500				$110,307.45	

On October 1, 1914, all of the above outlined work had been completed with the single exception of Jabez street, the paving of which was laid over, pending the construction of a large storm water sewer through the street. The only distinction stated in the Newark specifications as to size of block between new granite and napped, re-clipped granite block is to specify in the napped granite that no blocks less than six (6) inches in length nor more than twelve (12) inches shall be used.

The main object of this paper is to endeavor to awaken increased interest in this form of paving, which affords a chance to lay a durable and practically a new pavement at a very low cost. Any small town, or even village, in the eastern part of the United States having any old time granite pavements laid either on sand or concrete foundation, are in a position to get a new pavement at a minimum of cost. There is practically no use for worn out bricks or asphalt blocks. Old asphalt pavement can be used again when mixed with new material and melted down, but a granite pavement that has already given 25 years' service, may under the methods described in this paper give an additional service of 25 years, which would undoubtedly put granite as a paving material absolutely in the first place so far as durability is concerned.

DISCUSSION.

Mr. Blair: What do you mean by napped?

Mr. Howell: By "napping," I mean the splitting of the blocks into two or more parts by a blow or blows from a hammer. The blocks are broken through the head, the line or lines of cleavage being at right angles to the length of the original old block before napping. The new surfaces exposed by the napping constitute the *heads* of the "napped blocks." The blocks are then re-clipped or re-dressed to the dimensions required in the specifications.

REVIEWING THE ORIGIN AND PROGRESS OF LAYING RECUT OR CHIPPED GRANITE BLOCK PAVING, AS DONE IN THE BORO OF THE BRONX, NEW YORK CITY.

By S. C. THOMPSON, *Engineer of Highways, Boro of the Bronx.*

The use of redressed granite blocks, so far as the writer knows, originated in the Boro of the Bronx, and the first piece of work was done under a contract dated September 18, 1909 and it was completed during the succeeding year.

The redressing of granite blocks was suggested to the then chief engineer of the Boro by a contractor who was largely interested in laying pavements (especially granite blocks), and who also had extensive interests in granite quarries.

The events which led directly to the consideration of redressing old blocks were the letting of several contracts for repaving streets, where the old blocks were to be replaced with some other pavement, and the contractor was required in his bid to include a price per thousand for the taking up and removing of the old blocks from the street. The average price bid for the old blocks and their disposal was very low, it being considered that they were practically without value (the average price being \$6.00 or \$7.00 per thousand), and liable to be held by the contractor indefinitely.

The suggestion was made of trying to redress the blocks to a smaller size and relay with a cement grout filler, to insure the requisite stability. At this time (1909), the specification for granite pavement on sand, required blocks from 8 to 12 inches in length, 7 to 8 inches in depth, and from 3½ to 4½ inches in width, and the average cost for furnishing and laying was \$2.86 per square yard, the number laid in a square yard being about 22 blocks.

The proposition to recut these blocks and relay them on a concrete foundation resulted in making specifications for doing the work, following rather closely the same requirement for joints as had been previously used for blocks on a sand foundation. When the letting occurred, the contractor who had made the suggestion, proved to be the lowest bidder, at the following prices:

Taking up, redreshing and relaying blocks..........$1.27 per square yard
Concrete foundation (1-3-6 mixture)............. 4.00 per cubic yard.

The work done under this contract covered an area of over 20,000 square yards of repaving, and included only the space from the railway tracks, existing in the avenue, to the curb on either side. Between the rails, and between the tracks was relaid by the railway company with the original blocks, on a sand foundation.

The proximity of the two pavements laid by the different methods, furnished an excellent opportunity for comparison.

As a result of the satisfactory work obtained under the original contract, eight (8) additional contracts have been let and completed for this class of pavement, with modifications from the original requirements, in the proportions of the cement grout filler, the size of the joints and some changes in the method of laying. In the original contract, the grout filler was 1 of cement to 3 of sand, but at the present time it is mixed with equal parts of sand and cement. The joints as at first laid were limited to one inch, and laid to about ¾ inch, while at the present time, the maximum joint allowed is ½ inch. To October 1st, 1914, there have been laid in the Boro of the Bronx over 212,000 square yards of the redressed block pavement, which at contract prices has cost over $272,000.00, or about $1.30 per square yard average for taking up the old blocks, redressing the same, and repaving with cement grout filler. The concrete foundation is not included in the cost given, but as the concrete foundation would have to be provided, the cost of the pavement alone is comparable. The average cost of the redressed block pavement, with a 6-inch concrete foundation has been about $1.90 per square yard.

At the present time, the specification requirements for this kind of pavement are, that the block must be from 6 to 12 inches in length, 4¾ to 5¼ inches in depth, and from 3½ to 4½ inches in thickness, and they must be so dressed as to give a smooth surface and lay with joints not exceeding ½ inch. These requirements are practically obtained. The contractor is obliged to maintain the pavement for a period of one year from acceptance, as a guarantee of good workmanship. After this time, the pavement is maintained by the city.

On contracts recently completed, the average number of blocks laid per square yard was about 38 for ordinary work, running somewhat less per square yard on railroad streets, where long blocks were laid at the rails.

The manner of conducting the work under the contracts is as follows: After the blocks are loosened, the clippers start in, and with a tracer, score the blocks across the center and break them in two with a blow of a face hammer, leaving a smooth surface on each portion of the broken block. The edges are then dressed to the extent necessary to produce the required joint. As a rule, the clippers work independently, but occasionally two men work together, one man tracing the blocks, and the other breaking and dressing them. Each clipper throws his blocks into a pile, from which they are culled, then counted, and piled on the sidewalk.

The cost of clipping and redressing the blocks varies in accordance with the dressing required. Where the clipping consists of breaking the block in the middle and dressing the edges only, they have been let as low as $10.00 per thousand, and the tool sharpening done by the contractor.

Where long blocks for laying against the rails of a street railway are dressed alone, $15.00 per thousand and sharpening is paid. Where old blocks are redressed to produce modern granite blocks, for first class work it costs $25.00 per thousand.

On a railroad street, the blocks are taken up on one side of the roadway at a time, and traffic is maintained. As soon as the blocks are piled on the sidewalk (they are not removed

from the street for redressing), the contractor proceeds to turn out the curb, dress to such extent as may be required, then reset same with a concrete foundation and backing, with enough concrete placed in front to form a bond with the roadway foundation, laid later.

The roadway is graded to allow a concrete base 6 inches in thickness, with the top of foundation parallel to the finished crown of the street, and at such a depth below the same as to allow a sand bed not less than 1½ inches in depth, in addition to the paving blocks.

Upon this sand cushion the redressed blocks are laid with close end joints, and joints between courses not exceeding ½ inch in width; longitudinal joints must be broken not less than 3 inches. As the blocks are laid, the joints are filled to within 4 inches of the top with gravel which will pass a ⅜-inch mesh, and be retained by a ⅛-inch mesh.

The blocks are then rammed to an unyielding bed, with a surface conforming to the grade and crown of the street. After the ramming has been done, cement grout, composed of one part of sand and one part of cement is flushed into the joints. A second ramming is given before the grout sets, and the joints again filled to the top with a somewhat thicker grout well broomed into the joints, filling them fully to the top of the pavement.

Traffic is kept off the grouted blocks until the grout has had sufficient time to set thoroly, running from 7 to 10 days according to the conditions of the weather.

In most of the work done, a grout surface has been spread over the top of the blocks and then broomed to a smooth, uniform surface. Unless this is properly done, the surface is liable to wear unevenly and the grout will chip off, leaving the top of the blocks entirely bare, while adjacent blocks will be perfectly covered. This action of the mortar surface has caused considerable annoyance and the cause has not been satisfactorily determined. In some instances, it appears to be due to an insufficient ramming, in others, to allowing the gravel in the

joints to come too near the top of the block before the joint is grouted.

The quality of the granite block appears to affect the adherence of the grout, some of the very hard crystalline blocks not furnishing as good bond as those of finer grain and medium hardness. The writer would be very glad for any information that would explain this action and provides a remedy.

In the work done by Mr. Charles A. Mullen, Commissioner of Public Works in Schenectady, in 1913, many of the old blocks were found to be of sufficient size so that they could be split longitudinally and transversely, thus making four blocks of each one, and making an increase of about 100 per cent. in the area that could be laid after redressing. For instance, a block which was 12 by 4 by 8 inches would lay 48 square inches. This would be cut to make 4 blocks 6 by 4 inches square, or would lay 96 square inches in the block. This block, while shallower than the Bronx block, is reported to have made very good work at a low cost. An article by Mr. Mullen, in *Municipal Engineering* for May, 1914, enters into the cost of the work done in Schenectady, in great detail, as well as fully describing the methods of doing the work. He assures me that the cost data given in this article are based upon carefully kept returns, and are accurate for the work done. For the convenience of any one who may wish to inspect the Bronx work, I append information as to location, area and contract prices:

TITLE	Total Yardage	Granite Blocks Recut and Relaid per sq. yd.	Pavement per sq. yd. including Concrete Foundat'n
Webster Ave., from 165th to 171st Sts.....	20,227*	$1.27	$1.94
Park Ave. E., from 156th to 161 Sts.......	5,241	1.31	1.81
E. 151st St., E. 155th St., E. 157th St., E. 160th St., E. 161st St., Melrose Ave..	32,256	1.38	1.55
179th St., from Park Ave., to Third Ave...	1,815	1.75	2.60
Southern Blvd., from Willias Ave., to 138th St................................	26,672*	1.05	1.75
Third Ave., 150th St. to 177th St..........	71,369*	1.19¼	1.86½
Webster Ave., 178th St. to 167 St.........	24,902*	1.22	1.90
Tremont Ave., Webster Ave. to 3rd Ave...	6,371*	1.45	2.13
Tremont Ave., 3rd Ave. to Boston Road...	23,696*	1.53	2.36

*Railroad streets.

In the above mentioned contracts, any excess of blocks belonged to the contractor, and any shortage had to be supplied by him at his own expense.

DISCUSSION.

MR. BLAIR: Are the blocks cut in two in the middle and redressed by machinery or by hand?

MR. HOWELL: The blocks are cut into two or more fragments. In Newark we break them into two pieces through the middle of the block, the break being made in a line through the head at right angles with the length of the old block. No machine is used. All of the napping and re-clipping is done by means of hammers and chisels.

MR. BLAIR: Mr. Varrelman of St. Louis did that same thing over twenty years ago.

MR. HOWARD: In 1883, I was working in Berlin, and there the granite blocks were recut in whatever shape it was possible to get out of them, and they were then sorted into eight sizes, and used in different streets, of course one size here and one size there. The reason it has not been done more in this country is probably due to politics. Schenectady made a great success of it, followed by Albany, then Brooklyn, then Philadelphia, and now New York. It saves a great deal of money, is true economy, and is a splendid practice.

MR. POLLOCK: In 1907 the Street Railway Company in Manhattan Boro cut the blocks in two, making two new heads. There were some places where they required a shallow block, and in that way they got them, and they gave very satisfactory results.

MR. BLAIR: A few years ago we shipped granite blocks all the way from Georgia to Indianapolis, squared them up, shaped them over, reloaded them and sent them to St. Louis. Those machines that cut and squared the granite blocks were portable, and I should think could be used on the streets. Has any one had experience with such a machine, run with a gasoline engine?

THE PRESIDENT: Ten years ago I was ordered to investigate material to form a groove along a T-rail. I looked over the Wisconsin and some of the Southern granites, but could find no machine for putting the groove in. I was told that if any one would get a machine that would cut them close, so they would have smooth block, it would be a gold mine. I decided upon a granite grooved block, and at that time they wouldn't cut a granite block the width of a brick, and we had to take the width of two brick, from 8 to 12 inches long. They were laid along the rail and in between were laid brick. That was about nine years ago. And I was told that the cement grout filler wouldn't hold the block to the rail, but you will find some of them in Grand Rapids yet, and there are only a few places near the joints where they have broken away. This was Wisconsin granite, one of the hardest granites in the United States. The cutters knew the grain, and they split it as you would cordwood.

THE SECRETARY: The city of Schenectady did not find any machines that would do it satisfactorily, and they did it by hand. With the larger blocks they made them into four, and the smaller ones into two or sometimes three.

REPORT OF COMMITTEE ON MUNICIPAL LEGISLATION AND FINANCE.

NELSON P. LEWIS, *Chairman, Chief Engineer of Board of Estimate and Apportionment, New York City.*

Your Committee on Municipal Legislation and Finance begs to present the folowing report:

The subjects with which this committee has to do are not susceptible of very precise treatment, and the committee report will simply attempt to briefly refer to certain tendencies in municipal legislation and municipal finance, and to enunciate some general principles which is believes to be fundamental. The most notable tendency in municipal legislation is the disposition to grant to cities a greater measure of home rule than they have enjoyed in the past. Home rule, however, should not be construed as meaning that all questions of public policy should be determined by direct action of the electors or freeholders. The town meeting may be a suitable method of deciding such questions in a village or a small town, but in cities such as are represented in this Society, responsible administrative officials and duly elected legislative bodies must be given power to decide and must assume the responsibility of deciding all those matters. Satisfactory results are likely to be attended to the degree that technical questions are left to the determination of technical experts.

The initiative, the referendum and the recall are still on trial, and final judgment as to the success or failure of these principles in municipal government cannot be reached until they shall have had a longer and more thorough test. Even then the results will depend to a large degree upon the sanity and sound judgment of those called upon to administer city affairs through such machinery.

The conviction is fast growing that what have heretofore been considered the sacred rights of private property, and the inherent right of the individual to use such private property in any way he pleases so long as such use does not conflict with the letter of the law, must give way to the paramount interest of the public, and to the right of the citizen to a sightly, wholesome and convenient city to live in. For the tyranny of the individual property over the owner must be substituted a benign despotism on the part of the city over the citizen. In this case also success or failure will depend upon the moderation with which this power is exercised.

As to municipal finance, there is a growing tendency to conduct our cities on a cash basis. While it is easier to borrow than to pay cash, the pay-as-you-go policy is safer and more economical in the end. When the city's credit must be used, loans should in no case be for a greater period than the life of the improvement for which the money so raised is to be expended. This must be accepted as a fundamental business principle, but it is one which has been too long ignored by most of the American cities.

The value of cost data and a proper system of accounting cannot be too strongly emphasized, and the interest in, and growing appreciation of, the importance of this subject are very gratifying. Many forms for recording cost data, and many schemes of accounting have been devised. Some of them are unnecessarily complicated, and your committee does not believe the time has yet arrived for the adoption of standard forms for recording cost data or standard forms of accounting. The object of both should be, not to determine what an improvement has cost, and how that cost should be distributed among a great number of accounts, but how much it is costing, in order that the excessive cost of some particular item may be discovered and corrected while the work is still in progress. In other words, the object of cost data and accounting should not be the furnishing of an historical record, but should be the means of collecting defective methods while there is yet time to do so.

Your committee presents these few general statements in the hope that they will commend themselves to the Society, and that they may indicate the lines of investigation to be followed by future committees dealing with these subjects.

DISCUSSION.

MR. PARKER: I was interested in Mr. Lewis' paper. He spoke as though it were not known just how a method of accounting could be brought about that would tell the results gotten from it, as well as the distribution of the money expended and the cost of the different items. While statistics are usually considered dry, I have always been interested in them, and during the last two or three years I have worked a great deal with statistical matters. Up to ten years ago I worked with direct statistics, but about ten years ago I discovered by using the index system I could compare unlike things, and I went through the fifty departments of the city of Hartford and tabulated the statistics, and by that method any variation in the expenditures of a department, even as small as $10 in a department that spends $100,000 becomes apparent at once. It is working on the right hand side of the decimal point, and by using that method the comparative statistics for all cities are available. I use it in my own department of parks, and by that system I know within 48 hours of the time the work is done how I stand with each different appropriation. We have twenty-one different appropriations in the park department, and I get a balance every night or in 48 hours from the time the expenditure occurs. It gives me a chance to standardize the work, tells me where the money goes, and what we have accomplished with the money. After several years I can standardize my work, and hold my men to that standard. I know how much lawn a man can mow in an hour, I know what should be done in shovel work, and in sweeping, and the thing is so easily done. People use the index system of statistics so rarely that I think the Society should give it more attention. It enables cities to tie themselves together,

because, after all, no city is large enough to be a municipal unit. The municipal unit of the country is all the cities of the country, and that has never been illustrated better than it is in this Association. What any of you know is the common property of all the cities. If we use the index system of statistics, all these matters would be brought out clearly and in so concentrated a form that it would be of great assistance.

MUNICIPAL OWNERSHIP AND OPERATION OF ELECTRIC UTILITIES ON THE PACIFIC COAST

By C. WELLINGTON KOINER, *Pasadena, California.*

It may seem presumption for the younger portion of the United States—the children of the West—to contribute an article to be read at "The Hub;" but when we are requested to discuss electrical energy, one of the country's newest and most important resources, we are not timid. On this subject we can talk from experience and give the East much to think about.

The Pacific Coast country, from the North to the South, has made tremendous progress in recent years. Its laws have been re-shaped; therefore it is to be expected that laws governing municipal ownership of public utilities should have received attention in the general evolution that has taken place on this coast. The mighty instruments of Initiative, Referendum and Recall make it much easier to enforce proper conduct in municipal affairs, thereby making it possible for a city to enter into ownership of the public utilities without its success being endangered by politicians and those whose interests are inimical to municipal ownership.

The question of municipal ownership of all public utilities has begun to attract attention throughout the United States. Generally speaking the regulation of public utilities, privately owned and operated, has proved unsuccessful up to the present time, thus forcing the question of municipal ownership and operation of all utilities on to the leaders of public thought for their most careful consideration.

Scattered over the United States are 1,562 municipal light and power plants, representing in numbers about thirty per cent. of the central stations in this country. However, they are made up largely of small plants located in villages and

smaller towns. Among these municipally owned utilities are shining lights as to efficiency, which have obtained results by lowering the rates to prices unthought of a few years ago. The result is that particulars are being sought by other communities in order that they, too, may experience the benefits of like enterprise.

The largest municipal light and power plant is located on the Pacific Coast. Seattle, with a population of 313,000 has a plant that represents an investment of $5,000,000, employs 240 men, does nearly $1,000,000 worth of business per annum, and furnishes electrical energy to approximately 30,000 consumers. This plant commenced to furnish electrical energy for street lighting in January, 1905, and in September of the next year it rendered its first service to private consumers. Since then the business of the plant has developed rapidly, until in 1913 the revenue reached the sum of $910,477.35. The profit for that year, after accounting for all expenses, including depreciation, amounted to $242,257.68. The total surplus, or profit, to the credit of the plant since it began operation is $810,100.21.

In addition to this surplus, the plant is entitled to great credit for the saving to the public by reason of the difference between the schedule of rates in force at the time the city started furnishing electrical energy, and the rates charged since that time. For residences for the first 30 kwh, used of the maximum demand, the rate charged by the private corporation at the time Seattle projected its plant, was 20c per kilowatt hour. This rate was afterwards reduced to 12c, then to 10c. The first rate made by the city was 8½ per kwh., and in 1911 the city reduced the rate to 7c, and in 1912 again reduced it to 6c with a 50c minimum. The private corporation met these last reductions by similar reductions in its rates. It can readily be seen that the difference between the rates charged by the city's plant and those that the company would have collected had the city not built its plant, amounts to a great sum.

During all this development, the city has had to contend with the privately owned and operated utilities in Seattle. This powerful corporation, with all its influence, has opposed the city at every turn. However, the people have loyally extended their patronage to their own plant, and have loyally supported the officials in charge thereof and who have so successfully managed the property and brought it to its present high state of efficiency.

The plant was proposed by City Engineer R. H. Thompson in 1893. Mr. J. D. Ross is the efficient superintendent and the electrical engineer, he having been in charge of the plant's construction since its beginning.

Seattle is the fortunate possessor of hydro-electric power sites from which it has heretofore supplied all its electrical energy. However, it is now erecting an auxiliary steam turbine plant for emergencies.

The present rates for electrical energy for residential purposes are a maximum of 6c per kwh. for the first 60 kwh. used per month, and 4c for all current above 60 kwh., with a minmum monthly charge of 50c. The rates charged for commercial lighting are a maximum of 4c per kwh. for the first 100 kwh. used per month, scaling down to 1.32c; and power rates based on connected load of 1 to 20 H. P. are 4c scaling down to ½c. These rates are maximum and minimum, there being a number of intermediate rates. The rate for street lighting is 4½c per kwh. for all current used, measured at the distribution station, this rate including maintenance and operation of the entire street lighting system. Furthermore, by introducing the new nitrogen filled lamps, all the advantages to be derived in increased candle power go to the benefit of the city and not to a private company.

The *average* rates received for the various classes of service are as follows:

(All figures taken from the annual report for year ending December 31, 1913).

Class of Service.	No. of Customers.	Connected Load, kw.	Estimated† Maximum Load, kw.	Connected Load per Customer, kw.	Average Rate per kw. hr. 1913.	Average Monthly Bill 1912-13.
Residence lighting........	25,839	15,762	3675	0.61	$0.05988	$1.28
Business lighting.........	2,745	4,771	3340	1.74	0.02757	8.44
Power	617	5,690	3410	9.22	0.01549	19.86
Domestic power*	71	177	80	2.49	0.02180	3.03
Total for system....	29,272	26,400	....	0.90	$0.03430	$2.29

*Electric cooking.

†Maximum at customer. These peaks are at different times of the day for different classes of service.

This plant is a tremendous asset to the City of Seattle by reason of the fact that it attracts manufacturing industries to this city, by supplying cheap electrical energy for industrial purposes. In addition to this, cheap domestic light and power, and cheap and ample street lighting are benefits that can hardly be over-estimated, and must be experienced to be appreciated.

I wish to call attention to the fact that during the first two years, while developing business, a slight loss was suffered, as may be expected at the outset of most business undertakings. However, the small deficit incurred was subsequently wiped out by surplus earnings, which began in the year 1908, and now amount to the substantial figures quoted above, viz., $810,-100.21. Seattle is also engaging in the operation of some of its street railway lines.

Having presented the example of the largest city on the Pacific Coast, located in the North, I wish now to present the example of Pasadena, a city of 40,000, located in Southern California.

Pasadena was compelled to establish its municipal light and power plant because of poor service and the high rates

charged for electrical energy. Its plant was put in operation for supplying electrical energy for street lighting purposes on July 1st, 1907. On October 1st, 1908, the first service was rendered to private consumers.

At the time the municipal light and power plant was proposed, the residents of the City of Pasadena were paying 15c per kwh. At the time the city began furnishing electrical energy to private consumers, the rates were 12½c for the first 666 kwh. consumed in one month, less 10 per cent for prompt payment. The city established a rate of 8c per kwh., scaling down for quantity consumed. The private corporation immediately began to make flat rates, for the purpose of exterminating the peoples' plant. These rates were so low as to mean practical donation of current. At this time the city did not supply energy on all streets. The plant was still in process of construction and consumers were taken on as fast as the commercial lines were extended. On such streets where the city had lines, the private corporation made flat rates to such consumers as would accept its terms, anticipating the extensions of the city on other streets, and their offer of flat rates was made in advance of the construction of the city's lines. It was then recommended that the rates in the City of Pasadena be regulated so that a company should be allowed to furnish electrical energy only on meter basis, and not on a flat rate basis. In passing the ordinance it was so framed that any company could charge any rate it desired, provided the electrical energy was sold and measured by meter. This ordinance was obeyed by the city as well as by the private company.

The city having acquired sufficient business to justify the reduction in rates, a maximum rate of 7c per kwh. was established. At the same time the private corporation established a maximum base rate of 5c per kwh., with a view of preventing the city from obtaining custom, and thus making the city's plant unprofitable. However, their scheme did not prevent loyal Pasadenans from supporting their own plant even at the

higher rate. This support resulted in a larges output and enabled the plant to demonstrate its possibilities for lowering the cost of generation and distribution. The earnings of the municipal plant were such that the city again lowered the rates to a maximum base rate of 5c per kwh. for light, scaling down to 3c; and with a maximum base rate for power of 4c scaling down to 1.2c. At the time of this reduction to 5c, the private corporation was charging the same maximum base rate. It immediately lowered its rate to 4c, with the threat that it would go below any rate made by the city. This difference in rates continued until September, 1913. However, in spite of the difference in rates, during this time the number of consumers of municipal energy was increased to five thousand.

The city had the legal right to fix the rates for electrical energy, and could have regulated the rates of the private corporation to the same rates as those charged by the city. The writer favored this action, as he had always believed that a large corporation furnishing electrical energy to eighteen or twenty communities from a common hydro-electric system, should not play one or more communities against another by selling current below cost in one community to throttle a competitor located there, and recoup its losses by charging higher rates in the other municipalities.

The Unjust Competition Act, Senate Bill No. 53, Chapter 276, passed by the last State Legislature of the State of California, now prevents such unfair practice. The result was that in September, 1913, the private corporation raised its rates to those charged by the City of Pasadena. It was compelled to choose between this or adjusting its rates in other communities to correspond to those rates it had freely given in the City of Pasadena. The law now requires the filing of annual reports by utility corporations, and it was shown in the annual report made to the City of Pasadena in January, 1914, by the corporation question, that the company had lost money under its method of charges the previous year; while

for the same period the city showed a surplus of approximately $30,000 over all proper charges. Since the equalization of rates, the city has increased its consumers to 6,832 as of August 1st, with further increases since. Pasadena is the home of a large number of the Southern California Edison Company, and of approximately 76 of its stockholders. As a matter of course, the company brought to bear every possible influence against the successful operation of the municipal plant of Pasadena, and the writer believes that never has there been a more relentless utility corporation war than that which has been waged in the City of Pasadena for the past seven years.

When the first bonds were issued to complete the city's plant, no direct offer was made to the company by the city to purchase its system. However, in 1909, when the bond issue for extending the city's commercial service over the entire municipality carried by a seven to one vote, a proposition was made to the private corporation for the purchase of its distributing system, and also of electrical energy, provided it could be obtained cheaper than the city could generate it in its steam plant. The private corporation made a counter proposition to purchase the city's plant. The facts were the city was in the market to purchase, but not to sell. Since that time, the city has had negotiations with the company's representative with a view of purchasing its distribution system in the City of Pasadena, but without success, the company refusing to dispose of its property in Pasadena. It is doubtful whether the City of Pasadena will again offer to purchase the distributing system of its competitor, for the city has extended its lines throughout its entire territory, and the purchase of the company's system would too seriously burden the taxpayers with a large amount for duplicate property, most of which it could no longer use. Now that the rates are equal the fight will be finished on the basis of service, and with the gains that are now being made by the city it looks as though it would be only a matter of time when the city will have at least 80 per cent. of the business.

The question naturally arises in the minds of some people, "Why is it that everybody does not use municipal light and power?" This can be answered only by stating that corporations receiving liberal rates for their services, often use a part of the money they thus obtain from the citizens to deceive them through the medium of newspapers, periodicals, paid solicitors, and other means. Pasadena has been fortunate in having the undivided support of one good, clean newspaper. It had the support of both of our dailies until one was purchased and suddenly changed its policy.

It required something of a fighting spirit on the part of the city officials to stand up against the continuous and varied onslaughts of the corporation, and it required faithfulness and loyalty on the part of the citizens to pay to their municipal plant, month after month for six years, fully twenty-five per cent. more than the private corporation charged.

You will concede that in the past many cities have seriously discussed municipal ownership, but failed to get started, because of the opposition of private interests. Every success like that of Seattle or Pasadena hastens the time when the cities will be too strong to be affected by such opposition as the private corporations might offer.

This question was propounded by the corporation and never allowed to rest: "If the City of Pasadena had the right to regulate rates, why build a municipal plant?"

The answer is, that through no regulating body in existence in the United States today can a city regulate rates as low as can be made by a municipally owned and operated plant, when conducted as a business proposition. Heretofore, utility corporations have regulated the cities, instead of the cities regulating the rates for utility services. Now, however, a change involving a hard struggle is taking place, and during the course of this struggle cities are learning that it is far better to operate certain of their own utilities rather than to leave them in private hands, even under the best of regulation. Witness the rates charged in cities where regulating

bodies have attempted to regulate rates; compare them with the rates charged by municipally owned and operated plants, and you will find that the lowest rates in the United States are those charged by municipally owned utilities. It takes as much, or more, ability to regulate rates as it does to operate the utility. While applying ability in regulating it would be better to apply it to operation and let the cities' patrons as a whole receive all the benefits.

The saving resulting to the people of Pasadena by reason of the difference in rates charged by its competitors before the city entered the field, and the rates charged by its competitor in other towns of the size of Pasadena since, is a tremendous one, amounting to $731,083.96, more than enough to pay the entire cost of the municipal plant.

Pasadena has invested in its municipal light and power plant at the present time, after making all deductions for depreciation $566,633.75. After paying operating expenses, charging interest on the total investment, and charging for depreciation to the amount of $130,871.31, the city has accumulated a surplus of $71,110.08. This is in addition to the plant's having been self-sustaining during the entire period of its existence.

While the competitor of the municipal plant of Pasadena is enjoying the privileges of hydro-electric power, the City of Pasadena has been operating a steam plant, generating electricity by means of crude oil at prices ranging from 70c to 96c per barrel, or an equivalent rate for coal at $3.25 per ton. The people have been highly pleased with the service rendered by the city, for the reason that the steam plant, located in the city close to the distribution system, is much more reliable than long distance transmission lines which go out of service in time of storm, to the great inconvenience of consumers.

The rates for electric light for all classes of service are as follows:

INCANDESCENT LIGHTING.

"CLASS A"—The first 100 kilowatt hours, or less of energy furnished in any one month to any consumer, 5 cents per kilowatt hour.

"CLASS B"—The kilowatt hours of energy furnished in any one month to any consumer in excess of 100 kilowatt hours and not exceeding 500 kilowatt hours, 4½ cents per kilowatt hour.

"CLASS C"—The kilowatt hours of energy furnished in any one month to any consumer in excess of 500 kilowatt hours and not exceeding 1,000 kilowatt hours, 4 cents per kilowatt hour.

"CLASS D"—The kilowatt hours of energy furnished in any one month to any consumer in excess of 1,000 kilowatt hours and not exceeding 2,000 kilowatt hours 3½ cents per kilowatt hour.

"CLASS E"—The kilowatt hours of energy furnished in any one month to any consumer over 2,000 kilowatt hours, 3 cents per kilowatt hour.

ARC LIGHTING.

"CLASS A ARC"—The first 100 kilowatt hours of energy, or less, furnished in any one month to any consumer, 4.9 cents per kilowatt hour.

"CLASS B ARC"—The kilowatt hours of energy furnished in any one month to any consumer in excess of 100 kilowatt hours and not exceeding 500 kilowatt hours, 4½ cents per kilowatt hour.

"CLASS C ARC"—The kilowatt hours of energy furnished in any one month to any consumer in excess of 500 kilowatt hours, 4 cents per kilowatt hour.

A minimum monthly charge of 50 cents per meter of three kilowatt capacity, or less, and 30 cents for each additional kilowatt of meter capacity required, shall be made for each meter.

Free Gem lamps are furnished for replacements and Tungstens are sold at cost.

The rates charged for street lighting are as follows:

Arc lamps 6.6 ampere	\$60.00 per annum
80 c.p. Street Series Tungstens	\$12.00 per annum
Ornamental Cluster Lighting	3½c per kwh.

The following are the average rates received the past year:

Street lighting, for all purposes	4.681c per kwh.
Commercial and residence lighting	4.954c per kwh.
For all current generated	3.045c per kwh.
For all current sold	3.724c per kwh.

The rates charged for power for all purposes are as follows:

"CLASS A POWER"—The first 100 kilowatt hours of energy or less, furnished in any one month to any consumer, 4 cents per kilowatt hour.

"CLASS B POWER"—The kilowatt hours of energy furnished in any one month to any consumer in excess of 100 kilowatt hours and not exceeding 300 kilowatt hours 2.4 cents per kilowatt hour.

"CLASS C POWER"—The kilowatt hours of energy furnished in any one month to any consumer in excess of 300 kilowatt hours and not exceeding 500 kilowatt hours, 2.4 cents per kilowatt hour.

"CLASS D POWER"—The kilowatt hours of energy furnished in any one month to any consumer in excess of 500 kilowatt hours and not exceeding 1,000 kilowatt hours, 2 cents per kilowatt hour.

"CLASS E POWER"—The kilowatt hours of energy furnished in any one month to any consumer in excess of 1,000 kilowatt hours and not exceeding 1,500 kilowatt hours, 2 cents per kilowatt hour.

"CLASS F POWER"—The kilowatt hours of energy furnished in any one month to any consumer in excess of 1,500 kilowatt hours and not exceeding 2,000 kilowatt hours, 1.9 cents per kilowatt hour.

"CLASS G POWER"—The kilowatt hours of energy furnished in any one month to any consumer in excess of 2,000 kilowatt hours and not exceeding 3,000 kilowatt hours, 1.8 cents per kilowatt hour.

"CLASS H POWER"—The kilowatt hours of energy furnished in any one month to any consumer over 3,000 kilowatt hours 1.2 cents per kilowatt hour.

A monthly minimum charge will be collected for electrical energy of $1.00 per meter of 1½ kilowatt capacity, or less, and $0.75 for each additional kilowatt of meter capacity required.

These were thought to be the lowest rates in the United States, with the exception of Cleveland, which I understood recently passed a three-cent rate.

The following tables show the cost per kwh. of all current generated, and for all current sold:

	Current Generated	Current Sold
Manufacturing	.00767	.00938
Distribution	.00901	.01102
Interest	.00397	.00486
Depreciation	.00473	.00579
Total cost	.02538	.03105

After adding the operating expenses and charge for interest on the total average investment, and charging up sufficient to cover depreciation, the plant had to its credit for the year ending June 30th, 1914, a surplus of $29,360.92, making a total surplus of $71,110.08. I wish to add at this time that the Surplus and Depreciation Reserve have all been reinvested in the property.

The following pages include a balance sheet as of June 30th, 1914, a summary of seven years' operation, and a schedule of property and depreciation.

The City of Taçoma, Washington, with a population of 100,000, recently completed and put into operation a hydro-electric power plant. The city for some years has been operating a distribution system of its own and purchasing power from a private corporation at 1¼c per kwh., at the same time giving a maximum rate of 6c for lighting. The city showed wisdom in acquiring a water power site and has developed a plant of 20,000 kwh. capacity with approximately 16,000 consumers. The city now charges the following rates for electricity:

For Lighting—6c ranging down to 3c, according to quantity used in a month.

For Power—2.4c scaling down to .0045, depending upon the load factor and kwh. consumed.

PASADENA MUNICIPAL LIGHTING WORKS DEPARTMENT—BALANCE SHEET AS OF JUNE 30, 1914.

.....			$557,255.67
......		$684,966.49	
Lines,			
......o June			
30, 1914.		127,710.82	
			$557,255.67
Balance from Capital Account...			$ 69,017.43
INVENTORIES—June 30, 1914.......			20,743.46
PERSONAL PROPERTY			9,378.08
Autos, Tools, Furniture, etc		$12,538.57	
Less Depreciation Reserve.		3,160.49	
ACCOUNTS RECEIVABLE			18,168.91
Com'l Light and Power		11,996.52	
City Streets and Buildings		4,061.71	
Sundry Accounts		2,110.68	
OFFICE CASH			300.00
			$117,607.88

FUNDED INDEBTEDNESS			$275,150.00
Total Bonds issued		$327,000.00	
1902 4% (Trans. 1914)	2,000.00		
1906 4%	125,000.00		
1908 4½%	50,000.00		
1909 4%	150,000.00		
Less Bonds Redeemed...		51,850.00	
Paid out of Taxes....	43,725.00		
Paid out Oper. Surplus	8,125.00		
PREMIUM RECEIVED ON BONDS...			3,836.43
CONTRIBUTION FROM TAXES.....			209,251.81
Taxes of Year 1906....	52,332.35		
Street Ltg Approp. 1906	2,299.95		
Real Est.—Transf. 1914	6,000.00		
Loan—General Fund ...	40,000.00		
Bonds Redeemed.	43,725.00		
Bond Interest Paid.....	64,894.51		
			$488,238.24
Balance carried forward			69,017.43
			$557,255.67
ACCOUNTS PAYABLE			$ 5,311.26
Balance June Demands		$ 5,256.08	
Sundry Deposits, etc.		55.18	
RESERVE FOR INTEREST—Net Bal.			41,186.54
Chgd on Total Avg. Investment....		118,899.80	
Paid Bond Interest from Taxes	$64,894.51		
Paid Bond. Interest from Surplus	12,818.75	77,713.26	
OPERATING GAIN—Fiscal Year.....			29,360.92
SURPLUS ACCOUNT — Balance at July 1, 1913.			41,749.16
Oper Profits credited to July 1, 1913		50,749.16	
Less Charge—Muller Judgment....		9,000.00	
			$117,607.88

SUMMARY OF SEVEN YEARS' OPERATION.

Years	1906-07	1907-08	1908-09	1909-10	1910-11	1911-12	1912-13	1913-14
Receipts	....	$23,425.64	$45,875.76	$74,935.32	$110,011.10	$123,485.11	$138,889.41	$176,431.30
Operating expenses	$997.09	$17,688.71	$21,431.73	$36,068.56	$56,570.95	$63,700.30	$70,073.45	$96,641.66
Interest	....	8,771.92	11,454.47	14,909.24	18,387.79	21,627.37	20,728.54	23,020.47
Depreciation	4,466.62*	9,490.64	11,728.07	15,817.05	17,902.69	19,528.66	24,529.33	27,408.25
Surplus	....	....	1,261.49	8,140.47	17,149.67	18,628.78	23,558.09	29,360.92
Deficit	5,463.71	12,525.63	....	....	....	....	....	....
	0000.00	$23,425.64	$45,875.76	$74,935.32	$110,011.10	$123,485.11	$138,889.41	$176,431.30

Total surplus to date	$80,110.08
Less emergency claim, paid, charged to surplus	9,000.00
Net surplus	$71,110.08

*This depreciation covers period during constructoin of the plant 1906-07 and is premature. However, it goes to offset the changing of 60 cycle generators to 50 cycle, which change was made during the year 1910.

SCHEDULE OF PROPERTY AND DEPRECIATION.

Account	BOOK VALUE Balance July 1-13	BOOK VALUE Additions During Year	BOOK VALUE Total June 30-14	DEPRECIATION RESERVE Balance July 1-13	DEPRECIATION RESERVE Additions During Year	DEPRECIATION RESERVE Total June 30-14	Net Book Value June 30-14
Real Estate and Plant Buildings *	$20,475 78	$2,328.83	$22,804.61	$2,820.26	$682.01	$3,502.27	$19,302.34
Station Equipment, boilers, generators, etc.	199,200.43	12,714.28	211,914.71	35,276.55	8,222.30	43,498.85	168,415.86
Overhead Lines for Com'l Service, poles, crossarms, wires, etc.	153,477.36	27,981.14	181,458.50	16,741.19	5,715.02	22,456.21	159,002.29
Underground Lines, Com'l Service, conduits, cables, wires, etc.	4,030.94	5,531.57	9,562.51	78.56	139.90	218.46	9,344.05
Transformers	35,357.06	7,114.12	42,571.18	3,846.57	1,558.56	5,405.13	37,166.05
Meters	63,390.24	14,454.48	77,844 72	8,023.15	2,824.70	10,847.85	66,996.87
Overhead Lines for Public Lighting, poles, crossarms, wires, etc.	114,267.50	9,006.17	123,273.67	30,672.28	5,787.67	36,459.95	86,813.72
Underground Lines, Public Lighting, conduits, cables, wires, etc.	1,193.10	543.37	1,736.47	14.98	31.51	46.49	1,689.98
Street Incandescent Fixtures	7,143.24	188.88	7,332.12	1,292.37	361.88	1,654.25	5,677.87
Street Arc Lamps	6,468.00	......	6,468.00	3,082.36	539.00	3,621.36	2,846.64
Totals	$605,003 65	$79,962.84	$684,966.49	$101,848.27	$25,862.55	$127,710.82	$557,255.67
Personal Property, autos, trucks, motorcycles	$5,667.75	$647.75	$6,315.50	$667.91	$966.72	$1,634.63	$4,680.87
Tools and testing apparatus	2,013.84	626.80	2,640.64	180.50	232.72	413.22	2,227.42
Furniture and fixtures	3,342.80	239.63	3,582.43	766.38	346.26	1,112.64	2,469.79
Totals	$11,024.39	$1,514.18	$12,538.57	$1,614.79	$1,545.70	$3,160.49	$9,378.08

*Includes $8,000.00 value of land and wells at power-plant site.

For Street Lighting—$60.00 per year for arcs.

The City of Riverside, in Southern California, with a population of 17,500 voted bonds in 1895 for building a sub-station and distribution system, and has been supplying electrical energy since that time. It now pays approximately .008, per kwh. for power delivered to sub-station, and charges a maximum rate of 7c for residence lighting. Up to July 1, 1913, the plant had cost $503,577.71, and after making all proper deductions for depreciation the plant's value was $352,627.36. The city has the entire field, there being no competition, and the plant has proved to be a very good producer of revenue.

The City of Alameda, California, with a population of approximately 30,000, operates a very successful municipal plant, generating electrical energy with a steam plant. The maximum rate for lighting is 7c, ranging down to 5c, with a minimum of 50c per month. The power rate is 4c, ranging down to 2c.

I am submitting herewith a summary, and other tables of reports of municipal lighting plants of the State of California, for the year ending June 30th, 1913. These tables were prepared by the Municipal Lighting Committee of the Berkeley Club. Of course, some changes have been made since the tables were prepared.

City	Population 1913	Income from operating	Operating expenses	Operating profit	Fixed charges	Surplus of income	Bonds outstanding
Riverside	17,000	$143,984	$97,921	$46,063	$19,801	$26,262.18	$50,000
Pasadena	36,000	138,889	70,073	68,816	44,479	24,337.17	281,875
Alameda	28,000	131,727	65,386	66,341	25,673	40,668.31	193,750
Palo Alta	5,000	44,780	27,336	17,444	12,989	4,455.10	85,826
Glendale	8,000	40,495	19,178	21,317	13,466	7,850.19	95,500
Lodi	3,600	31,183	16,534	14,648	4,724	9,924.32	26,347
Ukiah	3,500	18,858	14,687	4,171	2,047	2,123.11	11,700
Colton	5,000	17,606	12,977	4,629	995	3,633.20	3,450
Santa Clara	6,000	16,790	9,041	7,749	2,702	5,047.30	14,000
Gridley	1,250	9,715	5,533	4,182	2,375	1,807.18	13,500
Azusa	1,500	8,196	7,673	523	750	277.08	......

Notes—Income does not include miscellaneous sales, wiring, etc., when they amount to any considerable percentage of the gross income.

Includes value of street lighting.

Fixed charges cover bond interest and redemption, and depreciation.

RATES IN MUNICIPAL PLANTS, 1912-1913.

	Minimum Light'g Bill.	Cents per k. w. h. Light'g.	Power.
(1) Riverside	$0.50	8 to 4	6 to 1.75
(2) Pasadena	0.60	5 to 3	4 to 1.5
Alameda	0.50	7 to 5	4 to 2
(3) Palo Alto	1.00	7.5 to 4	4
Glendale	0.75	8 to 6	6 to 1.75
Lodi	1.00	6 to 4	4
Ukiah		10 to 5	4 to 0.75
Colton	0.50	8 to 4	4 to 3
(4) Santa Clara	1.00	10 to 4	8 to 3
Gridley		10 to 2	10 to 2
Azusa		8	6
Anaheim	0.75	10	10 to 2.50
Healdsburg	0.50	10	5 to 3
Biggs		8	5

(1) Pumping $1.75; all lamps free.

(2) Some free lamps, Tungstens at cost, 1914 minimum reduced to $0.50. Power, 4 to 1.2c.

(3) 1914 power 3c, heating 2c.

(4) 1914 light 9c, power 7c.

The City of San Francisco has recently built and put into operation the Geary Street Railway, and the financial report for the year ending December 31st, 1913, shows that the road has been very profitable. I submit herewith the balance sheet covering the period, the same having been prepared by Mr. William Dolge, Certified Public Accountant. The chronology of this enterprise is taken from the Financial Report for the year ending December 31st, 1913:

December 2, 1902. Election. Proposition authorizing $700,000.00 bonds defeated.

October 8, 1903. Election. Proposition authorizing $710,000.00 bonds defeated.

November 6, 1903. Franchise of Geary Street, Park & Ocean Railroad Co. expired.

June, 1906. Budget appropriation $325,000.00 for Geary Street Railroad. Used for reconstruction and rehabilitation of streets and buildings, destroyed in disaster of April 18-22, 1906.

June, 1907. Budget appropriation $720,000.00 for Geary Street Railroad. Subsequently declared invalid by Court.

June 24, 1909. Election. Proposition authorizing $1,950,000.00 bonds defeated, lacking 203 votes.

December 30, 1909. Election. Proposition authorizing $2,020,000.00 bonds carried.

April 16, 1910. Superior Court declares bond issue valid in every respect. Decision affirmed by Supreme Court in July, 1910.

July 18, 1910. First lot of bonds, $121,000.00 sold.

Summer, 1911. Construction of Geary Street Railway commenced.

May 5, 1912. The Geary Street, Park & Ocean Railroad (cable system) ceased operations.

December 28, 1912. The Municipal Railway (Overhead trolley system), commenced operation on Geary Street from Kearny to Beach and Park, with ten (10) cars, under direction of Thomas A. Cashin, Superintendent, Mayor James Rolph, Jr., acting as motorman on first car.

April 22, 1913. Referendum election. Agreement with Sutter Street Railway Company respecting use of tracks on lower Market Street ratified.

June 24, 1913. Municipal Railway in full operation from Ferries to Beach and Park. 28 cars.

August 26, 1913. Election. Proposition authorizing $3,500,000.00 bonds for extension of municipal railways carried.

The City of San Francisco is proceeding with the municipal ownership of its railway, and is now preparing to take over the Spring Valley Water Company. The City will then be in possession of valuable water power sites, with which it can develop all the electrical energy it will need for its railway and other uses.

On May 8th, the City of Los Angeles voted bonds to the amount of $6,500,000 for an electric generation plant and distributing system, to be operated in connection with the Owens River Aqueduct. The vote was 56,199 for and 23,179 against.

MUNICIPAL RAILWAY—BALANCE SHEET AS OF DECEMBER 31, 1913.

Prepared in compliance with Charter provisions, Art. 12, Sec. 16, Par. 3, for comparison with privately owned utilities.

ASSETS.		LIABILITIES.		
Cost of Road and Equipment	$1,657,251.38	Funded Debt—Bonds Sold		$1,969,000.00
General Expenditures	181,890.14	Contribution from Premium on Bonds		2,341.50
Municipal Bonds Owned	93,300.00	Contribution from Taxes		238,692.47
Cash in City Treasury	547,627.08	Current Liabilities		161,312.92
Other Current Assets	53,228.68	Obligatory Charter Reserves, Art. 12, Sec 16		116,645.92
		Depreciation	$80,054.59	
		Taxes	35,454.00	
		Insurance	1,137.33	
		Surplus—Profit on Operations		45,304.47
	$2,533,297.28			$2,533,297.28

I have audited the above Balance Sheet and certify that it is correctly prepared from the accounts in compliance with Charter requirements to show the financial condition of the Municipal Railway of San Francisco as at December 31, 1913.

WILLIAM DOLGE,
Certified Public Accountant.

San Francisco, Cal., January 16, 1914.

With respect to the assets, the Balance Sheet as submitted conforms to standard railroad practice. With respect to liabilities and capital side of Balance Sheet, two novel points must be considered. Like a private corporation the municipal railway has a funded debt, but unlike a private corporation there is no capital stock. There are, however, [illegible] ital from premium on bonds and from taxes, direct and indirect, which are accounted under the [illegible] from Taxes" and are analyzed in Exhibit G.

The Charter also requires that depreciation, insurance and taxes shall be accounted, although the municipal railway has no taxes to pay. Resultingly, the deduction from income on account of taxes appears on the Balance Sheet as a credit to one of the "Obligatory Charter Reserves." The city's equity may, therefore, be said to comprise Contribution from Premium on Bonds, Contributions from Taxes, Obligatory Charter Reserves and Surplus, a total of $402,984.36 at December 31, 1913.

The City of Los Angeles, through long negotiations, has endeavored to purchase the distributing systems of all of the private corporations operating in Los Angeles, either through a plan of leasing with ultimate ownership, or through outright purchase; but the companies have refused, in every instance, to sell to the City. The people nevertheless voted the money, and if the companies do not sell, the city will condemn one or more of the existing distributing systems, or will proceed to build independent lines paralleling all of the systems.

The action of the various municipalities on the Pacific Coast in acquiring and operating their various profit earning utilities, is an example to other cities, showing what can be done when a municipality wishes to operate these utilities on a business basis and according to business methods, divorcing politics from their affairs and operating them for the benefit of the people.

It has always been conceded that American cities had the ability to operate all public utilities in which there was no profit, such as sewers, fire departments, police departments, schools, parks, jails, hospitals, insane asylums, etc., but the people who have profited by having an interest in privately owned public utilities supplying water, gas electricity, telephone service, street railways, etc., have always denied that the city had the ability to operate these for their own benefit and with success to themselves. However, the people on the Coast have arrived at the conclusion that it is best for them to own and operate all of the profit earning utilities as above enumerated.

As time passes and the American cities take over all profit earning utilities, there will be a manifest increase in efficiency in municipal government. Then there will be no public service corporation to influence public officials and place in office men who will do their bidding; then there will be no need for public service corporations to own and operate newspapers and periodicals for influencing public opinion on public policy; then there will be no long periods of litigation in an effort

to regulate rates and place proper valuations on the property of public service corporations; then there will be no need of appealing to railroad commissions and other commissions to compel corporations to give efficient service and courteous treatment to the public; then city officials can give all their time to the conduct of city affairs and its utilities without having to fight off the public service corporations; then American cities will offer greater attraction and greater incentive to the young man to enter the service of the municipality. On the passing of ownership and operation of public utilities from the private corporation to the municipalities, peace will reign in the conduct of municipal affairs where we now have much turmoil.

It is a fact that the operation of public utilities by private interests has caused more dishonesty in the affairs of American municipalities than any other thing. It was so in St. Louis, San Francisco, and other cities. By removing the cause we will cure the disease. The cause can be removed by the municipilization of all public utilities, operating them on a business basis absolutely divorced from politics. This can be done whenever the citizens of our land wish to have it so.

RECENT TENDENCIES IN CHARTER LEGISLATION.

By Nelson P. Lewis, *Chief Engineer, Board of Estimate and Apportionment, City of New York.*

Perhaps the most notable tendency in recent legislation affecting cities is the disposition to grant to them a larger measure of independence in the conduct of their business than they formerly enjoyed. Cities of continental Europe, especially those of Germany, have far broader powers than have those of the United States or Great Britain. It may be generally stated that the former can do almost anything not forbidden by law, while the latter can do only those things which are permitted or directed by general or special enabling acts. In the former the cities are to a large degree independent of the state, while in the English speaking countries the cities are the creatures of the state and they are constantly reminded of their dependence. It is not, or at least it was not until very recently, unusual for cities in the United States to be obliged to go to the State Legislature for permission to make any changes in the city plan, such as a change in the lines of a street, the closing of an existing street, the laying out of a new street, the establishment of new parks, or even in some cases the modification of street details, such as the widening of roadways by reducing the width of sidewalks. A large proportion of the laws enacted at legislative sessions dealt with details of this kind, which it would be natural to suppose would be determined by the local authorities. In Great Britain authority of Parliament was required for municipal improvements, especially those involving the expropriation of private property.

During recent years there has been a disposition to grant to American cities a far larger measure of home rule. Municipal legislative bodies are authorized to prepare plans for future

development, and to modify such plans once adopted in all their details. Instead of applying to the state legislature for authority to expend money for certain purposes and to issue their obligations for money borrowed, or to recover the cost of improvements by assessments, the cities are now quite generally left to determine these questions for themselves with the single provision, and that a wise one, that the total city debt may not exceed a certain percentage of the value of the real estate within the city as assessed for the purpose of taxation. This percentage varies in different cities, and in some cases debt incurred for increasing or improving the water supply is not included in estimating the city's limit of debt incurring capacity, as municipal water systems are usually self-sustaining, and frequently yield a profit. Again, as in the case of New York City, debt incurred for other projects which return enough to care for interest and amortization of the bonds representing their cost, such as the first Rapid Transit Subway and certain water front improvements, are also excluded in estimating the limit of bonded indebtedness.

American cities generally are obliged to conduct their business under charters which define in considerable detail the officers to be elected and appointed, and the matters over which and the manner in which such officers shall exercise administrative control. These charters are legislative enactments, and while many of them are special laws, there is a tendency in some of the states to prescribe uniform charters for cities of the same class, such class being determined by their population. The most recent development of the home rule idea for cities is the "commission" form of government. The first application of this idea was in the city of Galveston, Texas. In September, 1900, this city was almost completely wrecked by a violent storm and tidal wave and the city being already in a somewhat critical financial condition, the ordinary governmental machinery was inadequate to cope with the situation, and the administration of its affairs was turned over to a commission which was given extraordinary powers. The

scheme of government resorted to in order to meet a great emergency proved so successful that it was continued indefinitely.

Municipal commission government is not government by "commission" as some of the national or city functions are exercised through commissioners appointed by the executive or created by legislative enactment. The name in general use is said to have been adopted in Galveston for the reason that a majority of the first administrative board were appointed and "commissioned" by the Governor of the state to deal with the special conditions existing in that city. Two years later the members of the board were elected, but the name "commission" has persisted. The Galveston commission consisted of five members, one of whom has the title of mayor, although his duties and powers differ little from those of his colleagues. To these men is entrusted the management of the city's affairs, a specific function being assigned to each. The plan worked so satisfactorily in Galveston that it was soon taken up by other cities, and at the present time more than three hundred cities and towns in the United States have adopted it. Des Moines, Iowa, added to the Galveston plan a provision for a referendum vote by the people on ordinances, the initiative of municipal legislation by the people and the recall of elective officials before the expiration of their terms. In the state of New Jersey a law enacted in 1911 provides that any city or town in the state may adopt a commission form of government. The latest development of the idea is the "commission-manager" plan adopted by the city of Dayton, Ohio, at an election held August 12, 1913. This city, like Galveston, had been the victim of a great disaster due to floods in several rivers that united within or near the city limits, and while the idea was already in the air its adoption must have been to some extent due to the special conditions following this disaster. A brief abstract of some of the provisions of the Dayton charter will be given as affording a fair idea of its self-governing features:

The powers granted to the city include the right to acquire, construct, lease, and operate and regulate public utilities, to appropriate the money of the city for all lawful purposes, to create, provide for, construct and maintain all things in the nature of public works and improvements, to regulate the construction, height and material used in all buildings and the maintenance and occupancy thereof.

The form of government shall be known as the "commission-manager" plan, and shall consist of a commission of five citizens elected at large; the commission shall constitute the governing body and appoint a chief administrative officer to be known as the "city manager." Any or all of the commissioners or the city manager may be removed from office by the electors, and the charter stipulates the manner in which such a recall shall be submitted to the voters.

The city manager shall be the administrative head of the municipal government and shall be responsible for the efficient administration of all departments. He shall be appointed without regard to his political beliefs and may or may not be a resident of the city of Dayton when appointed. He shall hold office at the will of the commission and shall be subject to recall. The commission may discontinue any department and determine upon and distribute the functions and duties of departments and subdivisions thereof. A director for each department shall be appointed by the city manager and shall serve until removed by the city manager or until his successor is appointed and has qualified. The commission may appoint a city plan board, and upon request of the city manager shall appoint advisory boards, the members of which shall serve without compensation. The commission shall have power to provide for the construction, reconstruction, repair and maintenance by contract, or directly by employment of labor, of all things in the nature of local improvements, and to provide for the payment of any part of the cost of such improvement by special assessments upon both adjacent and contiguous, or other especially benefited property, but the amount assessed

against property especially benefited shall not exceed the amount of the benefits accruing to such property. The commission may provide in whole or in part the cost of replacing any improvement existing on a street at the time of the adoption of the charter by levying special assessments, but any assessment for such replacement in less than fifteen years from the date of a prior assessment for the improvement to be replaced shall not exceed fifty per cent. of the cost of such replacement. The director of public service shall be the supervisor of plats of the city, and shall provide regulations governing the plating of lands so as to require all streets to be of an appropriate width and to be co-terminus with adjoining streets and otherwise to conform to regulations prescribed by him. Whenever he shall deem it expedient to plat any portion of territory within the city limits in which the necessary or convenient streets have not already been accepted by the city so as to become public streets, or when any person plats any land within the corporate limits or within three miles thereof, the Supervisor of Plats shall, if such plats are in accordance with the rules as prescribed by him, endorse his written approval thereon. No plat subdividing lands within the corporate limits or within three miles thereof shall be entitled to record in the Recorder's office of the county without such written approval so endorsed thereon. .

The Dayton charter attempts to lay down some general principles of equity which should govern the city in its relation to the citizens, but does not hamper administrative officers with needless restrictions. It recognizes the right of responsible city officers to control the development of the city, and denies to the individual property owner the right to lay out his lands in any manner he sees fit without regard to a comprehensive plan.

There is a growing conviction that city administration is a science; that it may even be considered a profession rather than an incidental occupation for one who has been a faithful political worker and should be rewarded by his party. This

idea has not yet taken such a sufficiently firm hold as to be incorporated in municipal charters. A few cities have gone so far as to provide that heads of certain departments shall be experienced civil engineers, but they are still changed with every new administration. A practice which would have brought forth indignant protest a few years ago has become occasional though not frequent, and that is, the selection as city engineer for one city of a man who has demonstrated his capacity in another city. Some of you may recall the severe criticism of a mayor of New York who appointed as Street Cleaning Commissioner a man who was a resident of another city; yet Col. Waring's work in that departmest is remembered by many who cannot recall the name of the mayor who appointed him. Such an appointment today would cause little comment other than approval if the appointee were believed to be especially well qualified for the place. In some cities, however, the law requires that one to be eligible for such an appointment shall have been a resident of the state or even of the particular city for a certain period. The importance of the office of City Engineer is recognized in the uniform charter for cities of the second class in New York state by making him a member of the Board of Estimate and Apportionment and of the Board of Contract and Supply, in which he sits with the mayor, comptroller, city attorney and president of the municipal legislative body.

A power which is occasionally, but somewhat reluctantly granted to cities today is that of what is called "excess condemnation." In most of the states this requires an amendment of the constitution, the organic law usually limiting the compulsory taking of property to the precise land required to carry out a specific public improvement. Massachusetts and New York have recently so amended their constitutions as to permit the State Legislature to authorize by general or special acts any city in the state to acquire more land than is needed for such purposes and to dispose of the surplusage after the improvement shall have been carried out. This has been thought a

dangerous power to grant to cities for the reason that it might be used recklessly or corruptly, or both. The idea is based in part upon practical considerations and in part upon a theory which is accepted as thoroughly sound in European countries. The practical consideration is that it will avoid the serious mutilation of property by leaving unusable remnants. If these remnants can be combined into marketable lots the development along the line of improvement will be more rapid and its appearance will be more sightly. The theory is that of the right of the city to take a part of the unearned increment, that is, the increase in the value of property which has been brought about through no act of the owner but through the growth and development of the city, or through some public improvement carried out by the city. Caution should be used in the exercise of the right of excess condemnation, when given. It will increase the first cost of improvements to some extent, but the money is likely to come back and materially reduce the ultimate expense. It should not be undertaken with a speculative or money making purpose. London has been following this plan in its improvements for more than half a century, but there is only one case known to the writer where an actual profit has been realized.

Another recent tendency in municipal legislation in America which has been common in Europe for years is the placing of limitations upon the manner in which private property may be used, either by special legislation with respect to particular cities, or by giving to these cities power to make their own regulations. While for many years there have been laws governing housing and factory conditions, fire protection and sanitation, there is a growing belief that the owner of private property has no right to so use that property as to detract from the appearance of the city and impair the value of adjoining property, or to change the established character of a neighborhood; in short, that private rights must be subordinated to the public interest. Laws regulating heights of buildings and segregation of industries have been enacted by a

number of states, and cities which have been authorized by State Legislatures to make their own regulations have been prompt to avail themselves of this authority. The most radical action of this kind has probably been taken by the city of Los Angeles. By an ordinance enacted in 1909, the entire city with the exception of two suburbs is divided into industrial and residential districts, there being 25 of the former and but one of the latter. This does not mean that there is one great unbroken area of the city devoted exclusively to residences. The industrial districts are widely scattered and the residential district includes the remaining area, so that it entirely surrounds many of the industrial districts and really covers the entire city, with limited areas taken out here and there. Under the provisions of this ordinance the municipal authorities have summarily ejected a number of small businessess, such as laundries, from residential districts, and in one case a brick yard established before the district in which it was located became part of the city and operated for seven years before the law was enacted, was compelled to remove its kilns, buildings and machinery, notwithstanding the fact that the land upon which it was located contained deposits of clay which made it more valuable for this purpose than for any other. Appeals have been made to the courts, but the constitutionality of the law has been sustained.

The State Legislature of Maryland has by special law regulated the use of property in certain parts of Baltimore. The state of New York in 1913, authorized the municipal legislative body in any city of the second class, on petition of two-thirds of the property owners affected, to establish residential districts within which no buildings other than single or two family dwellings may be erected, such restrictions to continue until a similar petition shall have been presented to and approved by the same body. In 1912 Massachusetts so amended the general municipal law as to permit any city and town in the state, except Boston, which is covered by special acts, to regulate the height, area, location and use of buildings and other structures within the whole or any part of its limits. Minnesota in 1913 authorized the cities of Minneapolis, St. Paul

and Duluth to establish residential and industrial districts by two-thirds vote of the municipal legislative bodies when petitioned for by a majority of the property owners in any proposed district. This act also gives authority to classify the various industries and to restrict each class to a definite and limited area. Minneapolis has availed herself of this authority and has created certain industrial and residential districts. Wisconsin in 1913 conferred quite similar power upon eight of the principal cities of the state. The provincial legislature of Ontario, Canada, has authorized the councils of cities having a population of more than 100,000 to enact by-laws restricting the erection of buildings of certain classes to designate parts of the city. Toronto, acting under the provisions of this law, has prescribed the uses to which property may be put in a considerable portion of the city. Under this ordinance apartment houses and garages are excluded from most of the residential streets.

Several American cities have already imposed rigid restrictions upon the height to which buildings may be carried, that height being largely controlled by the width of the street on which they abut. Boston and Washington have perhaps gone further than other cities in this respect, and New York is now contemplating a comprehensive scheme for regulating building heights, in order that the excessively high office buildings, such as have been built in the lower part of Manhattan, may not be erected in other portions of the city.

There are other tendencies reflected in recent legislation which might well be noted, but those which have been briefly outlined seem to make it clear that city development and administration are coming to be considered of more vital importance than they were formerly thought to be; that the highest technical skill should be availed of in conducting city business; that a city should be permitted to manage its affairs in such a manner as its experienced and responsible officials and its own citizens think best; that the city is greater than the citizen, and that the right of the individual to do as he wishes must be subordinated to the sightliness, convenience and welfare of the city as a whole.

THE CITY EFFICIENT.

LOUIS L. TRIBUS, *Consulting Engineer.*
No. 86 Warren St., New York.

Within memories not the longest, taxpayers, wont to live in towns and cities, while using their free-born and much exercised rights in criticizing public officials and kicking generally, were still fairly content to do and live as did their ancestors.

Epidemics of disease finally drove to united effort, towards municipal sanitation and the getting rid of wastes into the next lower neighbor's water supply.

The survival of the fittest has not alone been the rule of Ancient Greece, but yea, even of modern America.

Public business was largely conducted in Sam Jones' Real Estate Office, the corner grocery or even the grog shop, except in very enterprising places which boasted a Justice-topped Town Hall, with columned portico, well equipped with rush-seated arm chairs and sawdust filled box spittoons.

But we would not laugh, for these, with the public square and its few trees, marked the modern beginning of a mighty movement culminating in the idea expressed by the phrase the "City Beautiful." We move rapidly in this electric age: Steam is to slow; we cannot take time to mine and burn the coal; we instead harness the mighty rivers and send their power to energize the motor; to light, to warm, to cook;—cleanliness vs. soot;—ease vs. comfort;—emancipation vs. slavery;—brains vs. brawn.

The "City Beautiful" develops apace: The "City Economic" is a necessary second, but only half understood by most publicists and community uplifters; and crowding on its heels comes the "City Efficient."

Ah! what a word to conjure with is "efficient;" with what pride the expert lifts his head, squares his shoulders and

gracefully allows his friends to whisper on the house-top:. "What a valuable man he is; what wonders he can accomplish," if granted a fat fee, many assistants, reams of paper and unrestricted field of examination and suggestion.

After his report has been filed, all neatly bound in flexible morocco, stamped with gilt title and accompanied by appedices of blank forms, he leaves for new fields and "most of the failure that frequently ensues" comes from mismanagement and neglect to fill out all the time and supply sheets in the right colored ink.

We do not for a moment decry "efficiency" or the well qualified conscientious "efficiency engineer"; but the world is too prone to accept high sounding words and plausible promises in place of substantial reality and often is too ignorant to appreciate the difference.

Efficiency has been the goal of every honest worker in every line, in all ages and it goes hand in hand with true economy, in the home in the factory and in the largest community.

Efficiency in American City Government can never be attained, with the constant changes due to the political system; —reformers come in possessed of or obsessed with, excellent theories, many of which they see fail when put into practice, and some are big enough men (and women) to recognize the failure and profit by it, but not all. Then when really valuable to the community and trained, largely at its expense, out they go, and the "outs" get in, to in turn receive their education; and the community foots the bill. Not unnaturally the incomers have trusted friends whom they desire to associate with themselves in the conduct of affairs, and there soon follow more "outs," lost to the municipality when most valuable and not infrequently largely lost to themselves also, for their best efforts have been given to the public; the procession of their former associates and business acquaintances has passed on, leaving them behind, largely unknown and soon forgotten.

This can never make the "City Efficient," yet it is the "City-as-is."

What is efficiency? Foolish question. Why ask it? But do we really know the answer? Is it not more than doing something with the minimum of waste, at the lowest cost, to give the largest output and have the longest life? Does it not reach far deeper and require an answer to another question? Is the thing itself or the output, necessary to private or public welfare or desirable for its best interests? That learned, the rest follows logically. As urban population increases, demands multiply in nearly geometric progression; usually per capita average wealth keeps fair pace with the demands, but it is an economic error to consider solely the average, though serving as a rough and ready means for comparisons.

Below 100,000 population there is apt to be a very fair general community sentiment and unity of interest; above that, class and wealth distinctions very rapidly become marked.

The rich look out for themselves, they travel; they buy every comfort; they can have every advantage of education; the world caters to their wishes as well as to their needs.

The poor are gradually being looked out for, and through public and private purse are provided with many facilities and opportunities for uplift;—pure misfortune, willful ignorance, shiftlessness or crime alone keeping them down or impoverished.

The great middle class (considered in point of wealth) is that which needs most public sympathy and thoughtful care. From its children come the strong, successful characters of the succeeding age; from its purse come the taxes that "make the wheels go round;" from its numbers come the teachers; from its men come, in large measure, our rulers, our "public servants," as we poetically and somewhat untruthfully call them; from them come the products that make for our best wealth.

But when a party wants votes, its representatives go to the cheap bar-rooms, the gathering places of the unemployed, the shops of the least skilled, and the decisions rest with them.

Where is the fault? Some economic lack in our educational system; some inefficiency that cost data records do not show?

Any one can ask questions; sometimes no one can answer them;—the foregoing are largely of that class.

But questions thoughtfully asked lead to knowlegde. It behooves the engineer and the sociologist to ask many, and carefully analyze the answers, but even then in important cases should trust only to the consensus of opinion of many independent thinkers.

So largely does population herd in cities and towns that, outside of transit public utilities, the problems of most engnieers are now urban in nature, so that health and financial ability are the prime factors.

Should present property ownership control or should owners of later years be taken into consideration?

Is present community financial ability to dominate, or the economy of a life time of use prevail?

If a certain public convenience must be supplied, and there are two ways of doing so, a comparison of the first costs plus repairs, obsolescence, interest, sinking fund and operating expenses, capitalized for the life of the utility, will give the economic values, but decision in favor of the "cheapest in the long run" might not represent truest efficiency, for the community at the time might not be able to afford its selection without too great a burden, even to secure greater gross economy through the life time period.

Generally, true economy will mean true efficiency, but not always.

Each term is, of course, relative, for the absolute is never reached in nature or practice.

Our larger cities are all struggling with the problem of efficiency; public offices are flooded with students of economics, social welfare and housing, and becoming congested with efficiency accountants.

Individual responsibility with decentralized control under centralized general management will secure the best efforts

of real men, though does not give the best *political* advertising to the general manager.

The bigger the man at the head, the more he will place responsibility upon subordinates and the more credit he will give them for results secured;—within reasonable limits, the greater independence that subordinates possess, the more will they exert themselves, and the more willing will they be to co-operate so as to unitedly secure results.

This is not theoretical doctrine, but conclusion, drawn from practical facts in a long experience, with many kinds of work in many places, and dealing with varying types of men, educated and ignorant, white and black, native and foreign.

The manager should know the cost of work produced, comparative and detailed, but need not concern himself, in a well-regulated organization, with the individual rate of pay and assignment of work of any man; but to avoid oppression he must be reasonably accessible for the direct presentation of any grievance by any employee.

This does not imply a hit-or-miss schedule of pay, but established rates for work of different classes, with flexibility within limits to meet individual merit. Some superior in charge, not far above the employee concerned, should have the say; he himself to come under similar control of a nearby superior.

Such a system requires knowledge of comparative values, not simply the cost of work in hand, and such value will very quickly regulate the general scale of remuneration.

In our cities of prolific cause of inefficiency comes from, not the complete independence of departments as some think, but the personal jealousies of their heads, under an unfortunate political system—where an elected President or Mayor, almost invariably appoints from political motives and selects men who have political ambitions of their own, which usually outweigh their best instincts and desire, to produce efficient results with their own corps of men.

What happens? Some Civil Service protected employee with years of acquired knowledge actually runs the depart-

ment, tactfully perhaps, but having no desire to have the smoothness of its running disturbed or too close inquiry made into the work qualities of the men under him.

Tons of cost data information and continuing knowledge of existing facts by general government central officials will avail nothing unless personal responsibility and authority obtain all the way down the line; authority to reward and authority to punish.

All credit to the conscientious worker for reform, the faithful investigator, the seeker after cost facts, the regulator according to pre-determined policies, the saver of apparent wastage, but, let us not hoodwink ourselves into believing that such action alone will secure true efficiency.

In one of our large cities the payroll sheets needed for one purpose only—that of showing total sums earned by particular men and funds involved actually show the daily distribution of time and drafts upon different funds involved noted for each man, not simply for the aggregate. This is a needless waste of time and duplication of accounting with no useful end attained, for no one above the man in direct charge of the group involved has any control over their assignment and service, and no one higher up has any real interest in the petty division of drafts upon the funds, yet this plan was evolved by much exploited efficiency experts as a means of establishing "control."

Countless instances of such absurdities could be mentioned out of the experiences of most city workers.

The writer's object, however, in this paper, is not to ridicule even the boaster and false claimant for efficiency honors, but to emphasize the necessity for consistency, and for a close study of basic facts and principles upon which to plan for public improvements, their execution and operation; and the governmental features of town and city life; the actual needs and abilities, not simply the wishes of the governed, or indeed the fads of temporary governors. Such study will raise up in time men fitted and able to secure all that can be desired for the "City Beautiful", the "City Economic" and the "City Efficient."

HINTS LEADING TO GOOD BUDGET MAKING FOR MUNICIPALITIES.

By WM. THUM, *Pasadena, Cal.*

Before taking up the question of municipal budgets, it is well to refer briefly to the general subject of municipal finance, budget making being one of its most important features; it is well also to impress first upon our minds the great and ever growing importance of municipal financial problems. Pasadena, California, for instance, a rapidly growing city of some forty thousand inhabitants, engages on her regular force about four hundred and fifty city officials and employees—including those in the city water department and the municipal electric light works—and in her public schools three hundred and fifty officials, teachers and employees. On the whole, these eight hundred employees work as earnestly and as effectively as do any equal number of individuals in private enterprises. Unless we except housekeeping, they perform tasks fully as difficult and as essention to human progress as those accomplished by any private enterprise, however, important it may be considered.

Assuming that twelve thousand employ their time regularly for wages, salary or profit, among Pasadena's population of forty thousand, we find that the eight hundred employees constitute six and two-thirds per cent. of the total number of workers, their labors representing practically this percentage of the entire work accomplished by her citizens.

Within the past twenty years, municipal activities have increased, perhaps two-fold, because of the increasing demand for such activities, occasioned by rapid growth and concentration of population in cities. During the next twenty years a much more rapid expansion of such activities is to be expected, to meet the changed conditions of the future.

Some European cities already render a great deal of utility and other service to the citizen. If he were compelled to buy these services from private corporations, he would have to expend on an average about one-third of his wages or salary, which is greatly in excess of what he now pays his municipality through taxes and utility rates. This statement seems plausible when we consider what the average man in America would have to pay to various private corporations if they operated his public schools; fire, police, park and street departments; sewage, gas and water works; garbage collection; incinerator; electric light plant; street cars; public amusements; baths; public markets; abattoirs, and other activities which are taken up by many European and, to a great extent, by many American municipalities. American cities will soon enter upon all of these and even other, activities; therefore, the financial problems of our cities are bound to increase rapidly in magnitude.

Municipal Financial Problems Not Appreciated.

When we take into account the importance of municipal work and also stop to consider its extent throughout the civilized world, we realize that the financial problems of cities are of far greater consequence than is indicated by the attention they receive in most quarters. But we are beginning to learn that successful municipal enterprise and development on a large scale is impossible without an efficient system of taking statistics, of determining unit cost, of bookkeeping, and of budget making—all these being essential elements in financing. Largely for this reason, I believe, there is no subject of greater importance before our municipalities today than that of an improvement in these various branches of accounting. Any future acceleration in our cities' material or social progress depends fundamentally on such an improvement in city accounting.

Regarding The Budget.

The preparation of the annual budget, if done with a keen sense of the relationships of values, should be one of the most

interesting and important problems of any municipal administration. In a measure, it controls the destinies of the city for twelve months, and its influence often extends far into the city's future. When compared with one more wisely drawn up, a budget prepared without due consideration and good judgment is, in the main, wasteful and detrimental to the general welfare of a municipality.

In preparing the municipal budget, it is necessary to determine approximately the maximum funds within legal limits that it is deemed advisable to raise for the operation and development of the city during the year. The final figure or amount of the budget is determined by a joint consideration of the urgency of the city's various needs, the tax-paying power of her citizens and the mental attitude of the public toward the proposed expenditures.

In considering for what purposes the public moneys shall be spent, we must not overlook the current scheme or policy of the city development; for, although, at times, it is necessary and economical, a serious break, change, or delay, in the current plan of development is usually wasteful.

The Budget Maker.

The budget maker, who is required to establish the relationship between the items of expense within each department and that between the appropriations of the several departments, should, of course, have a fair knowledge of all the activities that the cities of leading nations have found it advantageous to engage in, and he must be able to judge the value of these advantages to his own city, so as to favor the most profitable schemes for her advancement. But he cannot judge accurately without first knowing his city's needs intimately and in detail. This requires very complete and exact records intelligently analyzed year after year by the Auditor if he is qualified and has the time for the task or by an assistant engaged primarily for this purpose. The budget maker's work must be subject to review and should be carefully reviewed

by the mayor and City Council or by the City Commission as the case may be.

THE USUAL METHOD OF MAKING A BUDGET.

The usual way of preparing a budget for a city, say, up to 50,000 inhabitants is for the City Auditor, in the name of the Mayor and City Council, to request from the head of each department an estimate of the next year's financial needs of his department. The department head in turn requests of the City Auditor a statement covering the money paid out during the preceding year for his department. This statement is handed in with such arbitrary segregations, if any, as the Auditor may have voluntarily maintained during the year.

Such segregations are often made on illogical divisions and are nearly always inaccurate. Now, from the total amount of his statement the department head deducts the sum of the larger extraordinary items of expense incurred during the year just passed, which seem unlikely to be repeated during the new budget year. To this difference he adds the amount of such extraordinary expenses as occur to him and as are likely to be necessary during the year just beginning. The estimates of these extraordinary expenses are usually superficially made and their relative importance is not taken fully into account. As for all ordinary expenses, they are usually considered in the aggregate and are regarded as stable, with the exception of a regular annual increase. Finally, after some show of calculating, the estimate handed in to the Mayor is apt to be arbitrarily made a certain per cent. larger than it was the preceding year. This is done in the hope of meeting added expenses arising from growth in population and increasing demands of citizens.

A department budget so prepared has often but little value as a plan for the next year's activities of the department for which it provides, and it usually needs much trimming down to come within the limits of the resources available. According to new standards, it is a decidedly wasteful and incompetent piece of work.

PUTTING A LITTLE THOUGHT INTO THE BUDGET.

Where the city's accounts are not hopelessly jumbled, and some sort of discernment is used in the segregation of expense, the task of budget making is not an entirely unsatisfactory one. For instance, if it is possible for a street superintendent to learn with some degree of accuracy how much has been spent for street sprinkling during the previous year, and if he is able to make a fairly good calculation of the street area watered and to estimate approximately how much it has cost per square yard for each sprinkling—or the unit cost—he can act with intelligence in regard to the next year's estimates for sprinkling. With this as a basis, the next year's budget item for sprinkling may be determined. Pending the employment of a better method, the following scheme for assisting in the preparation of a budget may be of some assistance.

For the street department of a city having a population of from twenty to fifty thousand take four sets of cards at least three by five inches in size. Start with about thirty cards in each pack; mark all the cards in the first set, or pack, "A" and those in the other sets "B," "C" and "D" respectively. For reference, write the total amount expended for street sprinkling during the previous year on one of the cards "A;" also on this card, note the estimated sum required for sprinkling such streets which it is absolutely necessary to wet twice a day; likewise include the cost of those streets that must be sprinkled at least once a day; add, also, the cost of any special sprinkling that must be done during the year. In other words, on one of the cards "A" make an itemized estimate covering the various sprinklings that *must* be done. If the card is too small to make the desired segregation, use a sheet in a loose-leaf journal and refer to it on the card, merely writing on this card the latest revised total that is on the sheet. On card "B" place estimates covering the second sprinkling on certain of the most important streets provided on card "A" to receive only one sprinkling; also estimates for

such other sprinkling as may be highly desirable if still further funds be found available when the final adjustments are being made in the budget. On card "C" give estimates for sprinkling streets next in importance, and on card "D" all remaining streets on which sprinkling would still be a paying investment should it be found that funds can be spared for this purpose also. In short, each series of cards A, B, C and D is intended to contain an estimate for a specific outlay; card "A" covering such part of the estimated outlay as may be required for work already under way or contracted for, and such further part as may be considered of vital importance to the city; and cards B. C and D of the series covering respectively work of the same kind, but of receding importance.

Some public outlays do not permit of division and others would not lend themselves to division into as many as four parts; but this, of course, would not interfere with the use of a card system, as any number of the cards in a series may be left blank. It may, for instance, be decided that, in case funds are available after all the class "A" and class "B" expenses are provided for. the Park Department shall purchase and equip a new playground. In such case the estimate in the Park Department for this playground may appear only on a card marked "C," or the estimate for the less essential part of the equipment may be left off of card "C" and placed on a card "D." Every card, whether left blank or not, must, in addition to the letter A, B, C or D, have a title, such as "Street Department—Street Sprinkling," or "Park Department—New Playground." The blank cards referred to are a convenience because it frequently happens that an item starting out on one card is later subdivided on two or more cards.

After cards are prepared for each item of prospective expense, the next step is to arrange the cards marked "A" in a row so that the estimates of most importance are at the beginning and those of least importance at the end. Place the cards B, C and D in alphabetical order at the right of the cards "A" to which they belong. From this time on it is a

fine little game; for the consideration of all estimates in relation to each other requires the re-arranging of cards in the rows, shifting cards from one row to the other, subdividing items on some cards still further and condensing those on others, changing the relative amounts on the four cards within any set—A, B, C, D,—changing the relative total amounts covered by any such sets. This is continued until the best program of expenditures coming within the amount available has been ascertained.

Four rows of cards may be maintained advantageously; but the letters A, B, C and D on the cards may no longer indicate to which row a card belongs, since, as just intimated, some of these cards will be shifted from row to row as a result of adjustments that seem advisable.

Usually the budget maker will find that he must take the initiative in arranging the cards for the various departments; but, whether he does this or not, he must be present when the cards are being arranged by the department head, so as to be familiar with the entire process of thought that has brought about the arrangement. The cards should be numbered consecutively as arranged, and a written statement made thereof. This statement is the department's own estimate, ready for the budget maker's consideration.

After receiving all the statements and arranging all the cards of every department as each department head has planned, and after making a careful comparative study of the estimates made by all the departments, the budget maker will arrive at the relative sums best to apportion to each department from the entire available amount, and he must usually re-arrange the cards—especially for such departments whose estimates have to be cut materially—for the reason that at least in some directions a different line of action may be followed by a department if it can have, say, $100,000,00 than if it have only $80,000.00. In most cases the estimates of all departments have to be reduced and final and extensive re-

adjustment made; but they cannot be made to good advantage in the absence of modern accounting, modern statistics, and modern cost keeping.

Only a Partial Outline.

The above is merely a partial outline of a temporary plan to assist in budget making. Variations and additions will suggest themselves as the work progresses. If fair judgment has been used in segregating the city's accounts and the segregation has been carried on to a moderate extent, the budget maker, if he learns the possibilities of the game and gets into the spirit of it, may find himself playing with from two hundred to four hundred cards. Once accustomed to the work, however, and having a good knowledge of the city's needs, the right man, even under the present unfavorable circumstances, can do some effective work, and it is a necessary work when we realize that for many a city of from 30,000 to 50,000 inhabitants between $400,000 and $1,000,000 is annually distributed, exclusive of school expenditures. In some cities a careful well-informed budget maker, through his influence over the municipal appropriations, could eventually make a decided change for the better in the city's trend. Not many men, however, are mentally equipped to do this kind of work really well; for it is as different from the customary haphazard way employed by most cities of 10,000 to 100,000 in preparing their budgets as is the work of the modern chemist from that of the old time alchemist. Operating a city without first preparing a well considered budget, although very frequently done, is in a measure like constructing a city hall without first preparing detail plans. A budget is, or should be, a detail plan covering a year's prospective operations. Since almost any budget is better than none at all, it becomes an almost impossible task to get the present-day city official to see the vast superiority of a budget scientifically prepared.

WORKING FOR A BETTER BUDGET—AN ILLUSTRATION.

Early in the term of office of a certain mayor of my acquaintance, he was called upon to pass final judgment on a budget for an enterprising city of about 35,000 inhabitants. The estimates made by the various departments amounted to approximately $700,000, every dollar of which could have been spent advantageously. This amount was exclusive of that needed for schools, which were separately financed and under the sole control of a Board of Education. On account of the city's rapid growth, each year's needs for funds increased about ten per cent over that of the preceding year, and, on account of the City Council's policy to accomplish a large amount of permanent work through direct taxation, the sum required was relatively large. It was found that the maximum which could legally be raised for general city purposes was, say, $600,000. The City Council decided, however, not to go to the limit, and restricted the Mayor to $550,000, thus enforcing the elimination of $150,000 from the original estimated total of $700,000. Upon interviewing the various department heads in regard to reductions, it became apparent that some of them made their budget estimates in an entirely casual manner and that these were hardly a basis for the next year's action; that there was no intention on the part of most of the chiefs of departments of adhering closely to the segregated items of expense they had prepared. They cherished a hope and belief that, in some manner or other the total expense of their respective departments could be kept within the appropriation that would be finally allotted to them. It was generally the amount of the preceding year's total expenses of any department that determined the size of the estimate handed in for the year just beginning, and the various subdivisions in the budget were in part little more than matters of form.

About $100,000 of the previously mentioned excess of $150,000 was cut rather easily from the estimates. In regard to $50,000, however, the problem was more difficult. The city's

future was vitally concerned when the question arose as to which departments should bear this cut of $50,000 and in what proportions. Questions like the following arose: Should three thousand dollars of the fifty thousand be spent in the Health Department for increasing the equipment in a certain branch of its laboratory? Should this amount be added to the appropriation for garbage collection, or should a survey be made of the city sewage disposal problem? Should it be spent by the City Engineer for new instruments and for the salary of an extra draftsman, or for the repair of some culverts that might become dangerous before the year was out? Or by the Fire Department for the addition of more firemen to the force? Or by the Police Department? Or by the Street Department for a further extension of the street cleaning work or for a street repair outfit? Not having any statistics to indicate the social and financial value of any certain branch of the work of the health department's laboratory, or the cost per residence of collecting garbage in the various classes of districts, or having any data showing the cost per square yard of the different kinds of street cleaning, nor having any statistics showing the amount of past repairs or the present need of repair to pavements, or any adequate information covering the other branches of contemplated improvements or expenses; the benefits of spending $3,000 in these activities could not in the short time available be intelligently weighed against each other. Certainly a dilemma for a Mayor desiring to do thorough work!

A study of the budget problem emphasized the fact that the City Auditor should maintain a double entry controlling ledger; also that, while keeping all of the city's accounts in perfect balance, he should segregate them in such manner as to make them lend themselves to analysis in every important direction. Accordingly, the Mayor made an investigation of the art of municipal accounting, and tried to find an expert accountant who had practical experience in putting municipal books on a double entry basis and who was competent, also, to

modernize the method of a city's accounting in its lesser points.

Nearly two years passed before two available accountants were found and their eligibility fully investigated; for, at that time, good municipal accountants were even more scarce than they are now. In the meantime, the Mayor's term of office was drawing to a close and it was decided merely to suggest to the succeeding administration that they make the needed change, and to recommend to them the accountants who had been found competent. The suggestion was acted upon and the city now has a limited double entry system of accounting.

In the beginning of the Mayor's term of office it became apparent that any endeavor to take the further advance step of segregating the items of income and expenditure properly on lines that would permit of the most intelligent analysis of the city's activities would meet with opposition from some of the department heads, arising from that prevalent mental inertia that reveals itself in opposition against doing or even fairly investigating anything out of the ordinary. However, the heads of the electric light and the water departments both kept their books and records according to modern standards.

Nevertheless, to start the ball rolling, a special department was formed early in the administration to develop the desired accounts, records and statistics of the street department, without calling upon the superintendent or his assistants, or any of the regular employees, to give the matter any special attention. This work was almost concluded at the end of the Mayor's term of office. It took coercion to bring the Street Department and its special councilmanic friends into sympathy with the plan; but they finally awoke to the benefits to be derived from the system, and the Street Superintendent showed a willingness to take into his own office the special accountant necessary to keep up this work. This course was later endorsed and continued by the following administration.

Opposition to improvements in accounting, brought about by lack of adequate information, will soon be a thing of the past in all progressive communities; but until then reformers

in municipal accounting must expect to contend with it as a regular part of their work. Improvement in budget making must suffer delay accordingly.

The First Step Prior to Budget Making.

The first step in preparing the way for better budgets is to keep the city's books by some double entry system. A double entry controlling ledger leads to greater accuracy; it gives the Auditor a feeling that he is doing at least one important thing right as far as it goes; it stimulates the desire for efficiency; it breaks the mental immobility that has kept the Auditor's office from advancing, and it gives him a certain measure of security in making his accounts.

If I were asked to make an estimate of the worth of the double entry system of accounts for municipal purposes as compared with any single entry system now in use, I would say that it is worth over one hundred dollars annually for every thousand inhabitants, regardless of its great additional value as a first step to the further advancement of a city's accounts.

Advantages of the Double Entry System of Accounting.

Since thorough accounting is one of the first essentials in good financing, and since double entry bookkeeping is one of the first steps in thorough accounting, I shall endeavor to describe, briefly and simply, the main features of a certain practical but limited system of double entry controlling accounts for municipal books. This system, I believe, was evolved by William Dolge, and discussed by him in "Pacific Municipalities," of August 31, 1912, on pages 398 to 402 inclusive; also in a paper presented by him at the Fifteenth Annual Convention of the League of California Municipalities, held at Berkeley, California, September 23 to 28, 1912.

My object is to give the briefest possible summary of his discussion, as I have interpreted it, so as to enable anyone accustomed to accounting to understand the system. Above

all, however, I wish to show that the introduction of double entry in a city's books can be made an extremely simple matter. The particular forms to be adopted for the various receipt account books, such as tax, license and permit books; appropriation and fund ledgers; demand and warrant register, and others, will suggest themselves to any Auditor who sets himself seriously at working out the problem. Any desired modifications in the double entry accounts will also suggest themselves.

A Simple System of Double Entry Controlling Accounts for a Municipal Controlling Ledger.

1st. Budget Revenues Account, Dr. At the beginning of the fiscal year, or July 1st, debit the Budget Revenues Account with the total amount of the estimated revenues from all sources for the year, including the cash carried over from the previous year. At the same time credit the total of all appropriations to the *Appropriation Account*, and credit the remainder, if any, to *Surplus Account.* The Appropriation Account of the Controlling Ledger should always equal in amount the total sum of the individual appropriation accounts in the Appropriation Ledger. That is to say, at the close of every month, or of any shorter period adopted as the time for posting in the Controlling Ledger, the Appropriation Account should be in balance with the Appropriation Ledger.

2d. Receipt Accounts, Dr. On July 1st enter to the debit of each individual Receipt Account in the Controlling Ledger the estimated year's receipts that are anticipated to come in through such account. At the same time enter to the credit of the *Budget Revenues Account* all of the amounts thus debited to the various receipt accounts.

A partial list of receipt accounts is here given: Taxes Collected, Licenses Collected, Fees Collected, Fines Collected, Franchise Moneys Collected, Library Fines Collected, Sale of Old Material, Receipts of Municipal Industries, and others. New receipt accounts may be introduced during the year with-

out causing any disturbance in bookkeeping; however, such new accounts will, of course, have no initial debit entry.

It seems to me that, since the cash on hand at the beginning of the year must be included in the debit side of the *Budget Revenues Account,* it will, upon the opening of the books, have to be debited to a separate "Receipt Account," opened for this special purpose, and at the same time credited to the Budget Revenues Account; after this, it must be regarded as cash received, then credited to the Special "Receipt Account" referred to, and then debited to the proper fund account or accounts.

3d. Appropriation Account, Dr. At the close of each month, or at shorter intervals, debit Appropriation Account with total amount of all demands received for payment during the interval, as shown in the Demand and Warrant Register. At the same time credit the *Creditors' Demands Payable* account with a like amount.

4th. Fund Accounts, Dr. Debit to the appropriate Fund Accounts daily all moneys that have been received, from whatsoever source, and turned over to the treasurer. At the same time credit each of the appropriate *Receipt Accounts* with such part of the total as may have been received through it. A partial list of the Fund Accounts is here given: General Fund, Library Fund, Bond Interest and Redemption Fund, Public Industry Funds, and others.

5th. Creditor's Demands Payable, Dr. Sometimes it becomes necessary to reduce the prices in a demand. or to reject the demand in whole or in part. In such cases, enter the amount of the reduction or rejection in a column provided for the purpose on the Demand and Warrant Register, and at the end of every month, or of any shorter period, debit the sum of all reductions and rejections to the Creditors' Demands Payable account. At the same time credit the *Appropriations Account* with a like amount.

6th. Creditors' Demands Payable, Dr. At the end of every month, or of any shorter period, debit the Creditors' Demands

Payable Account with the total amount of all warrants drawn during that period in payments of demands. At the same time credit the entire amount to the appropriate *Fund Accounts* respectively, each with its individual share of the total.

The keeping of a double entry controlling ledger in this simple way would increase the clerical work in the Auditor's department less than one-half of one per cent over what it would be with a fairly complete single entry set of books. On the other hand, the benefits derived would be incomparably greater.

A SHORT EXPLANATION OF EACH ACCOUNT.

1. The *Budget Revenues Account* shows at the beginning of the year the total estimated income from all sources for the year and at the close of the year, it is used, in addition, to show the adjustment between the estimated and the actual total income. To a great extent it is a controlling account for the Receipt Accounts mentioned in the following paragraph.

2. The *Receipt Accounts* show individually, by their respective current balances, the amounts of estimated receipts of their respective kinds still remaining uncollected. At the close of the year, each of these accounts is made to show also the adjustment made between its estimated and actual receipts.

3. The *Appropriation Account* shows by its current balance the total sum of all balances in all appropriation accounts kept in detail in the Appropriation Ledger; these balances being not yet encumbered by registered demands.

4. *Fund Accounts* show by their current balances how much money is in the Treasury for each fund, in excess of warrants drawn against it.

5. *Creditors' Demand Payable Account*, by its current balance, shows the amount of liabilities for which demands have been presented and accepted, but for which warrants have not yet been drawn.

The following diagram, intended to picture the method of making these entries in the Controlling Ledger, is self-explanatory:

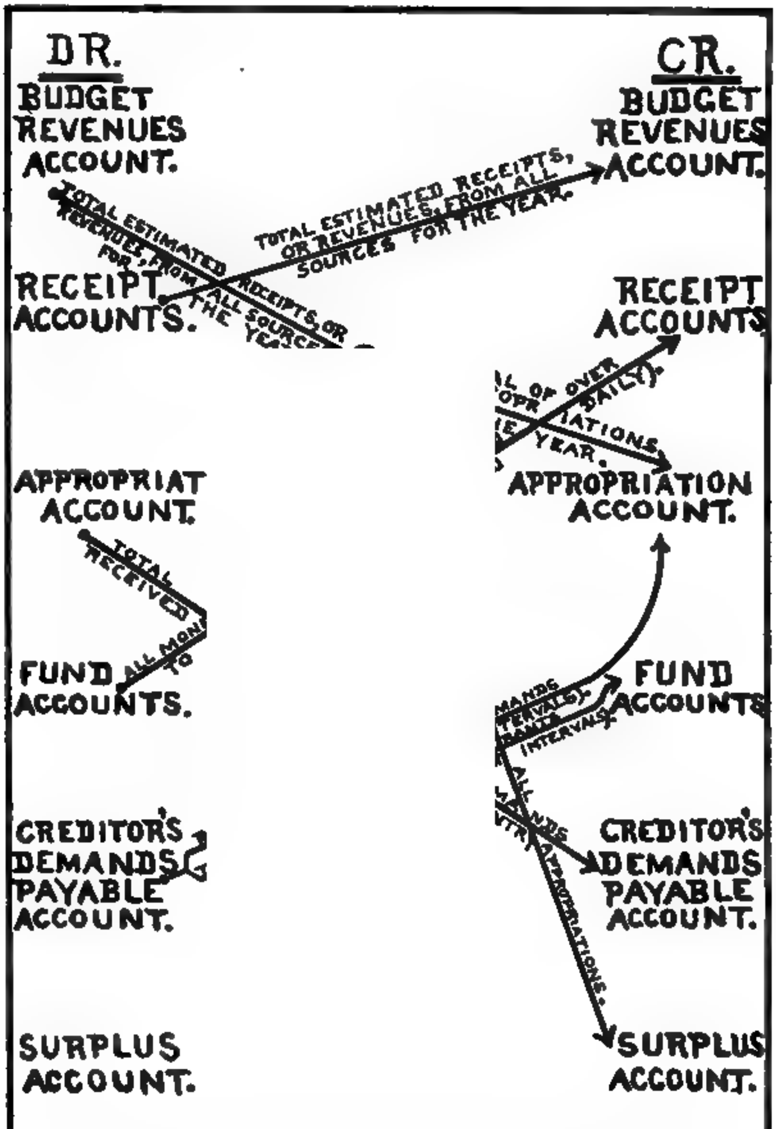


DIAGRAM OF ENTRIES FOR A LIMITED DOUBLE ENTRY CONTROLLING LEDGER OF MUNICIPAL ACCOUNTS.

As already stated, it is my belief that the introduction of a limited system of double entry would be worth more annually than one hundred dollars per thousand inhabitants to any city not now making some attempt at double entry accounting. And an Auditor of such a city, unless he have a very rigid mentality, can, by taking a year's time, certainly inaugurate such a system without professional aid. At the end of this period, he might study with profit that well known "Handbook of Municipal Accounting," published in 1913, by the Bureau of Municipal Research of New York. The plan of double entry accounting discussed in this book is much more complete and, therefore, more valuable than the limited system just outlined. Yet it, too, is very simple, there being hardly more than three times as much to learn as in the short outline just given. After such practice and study, he would be prepared to inaugurate the more complete system himself, or at least to intelligently insist on an adequate appropriation to engage experts for the purpose of furnishing his city with this or some other highly efficient system of accounting, and to assist him in starting his office under the new method.

Segregated Accounts and Records.

After the introduction of a double entry system of bookkeeping, the next step in preparing the way to good budget making is to develop a system of highly but practically segregated accounts and records. In the first place, we must determine what it is advisable for accounts and records to show, in order that they may facilitate the work of statistic making and of cost keeping. This is work for the combined efforts of experts and men in actual practice.

During my term of office, I often wished that the kind of information given in the following paragraphs were available. In the main, it would have been of the greatest assistance to the administration in considering the budget. I am certain that the suggestions will be considered rather impractical by some on account of detail; but the importance of the subject

warrants the making of such suggestions if only in the hope that they might be made practical later. Personally, I feel confident that municipal accounting will be carried on in even greater detail than is here suggested, and as much of it will be done with automatic mechanism.

1. Each of the "demands" presented for payment to be attached to an official revision thereof, the items being so divided as to allow of a proper segregation for accounting. Each demand should be consecutively numbered, and their separate items should also be consecutively numberd with a secondary figure. For instance, Demand Number 3000 might have three items numbered from one to three. It may happen that a certain item applies to more than one subdivision, or segregation, in an account, in which case it would have to be split in the revision and its parts considered as separate items and numbered accordingly.

In connection with each item should be shown:

I. (a) Consecutive number of the demand; (b) consecutive secondary number of each item on the demand; (c) date of purchase; (d) creditor, preferably designated by number; (e) city department for which material or labor specified in item was obtained—also designated by number; (f) each item further numbered so as to indicate its relative position in the account of the department to which it is to be charged; (g) a number or numbers indicating to which departmental account the item is to be charged for purposes of segregation; (h) official name of material or employment, written in the proper index form; (i) quantity; (j) unit price; (k) cost of item.

All of these data are meant to accompany the item wherever it may appear in the accounts or on the records, and they are intended (a) to aid in tracing any such item directly to its source, or origin; (b) to assist in properly entering the item in the various municipal accounts and records. After the foregoing preparation of the demands, each item thereon is placed in the various records and accounts, as indicated by the data accompanying each.

II. An individual detailed account, kept by the Auditor, with every creditor. This should include all office employees and all laborers, if size of city does not make the inclusion of the latter impracticable. It will enable the investigator to check up any creditor's account conveniently.

III. Itemized *and segregated* accounts, kept by the Auditor with the Purchasing and Supply Department, and with all other departments doing business directly with those supplying material or services to the city. If the Auditor fully itemizes and segregates the accounts with these departments, the accounting work within each department is simplified; since, so far as it goes, it need not necessarily be done anew by the various departments.

IV. Itemized *and segregated* accounts kept by the Purchasing and Supply Department with all other departments that are supplied through it.

V. An alphabetically arranged list on which is entered every kind of material and service paid for, giving quantities and prices. The purpose of this list is primarily to supply information covering prices and quantities, in order to facilitate purchasing.

VI. A unit cost system. To determine unit costs, the accounts and records should be accurately classified and segregated. This should be done by recording data in such a manner as to show clearly the relation between each piece of work accomplished and the material and labor used for its accomplishment, and to make available for popular use clear and interesting reports. It is here intended that both common labor and salary demands should contain a complete segregation of the classes of work done, in order that a unit cost system may be maintained to almost any extent, and to any degree of accuracy.

All of these accounts and records should be kept in perfect balance with their respective controlling accounts. Probably this cannot be done economically in the larger cities until a plan or scheme is devised by which, if one entry is made in one

account, it will mechanically reproduce itself and quite automatically place itself in the remaining accounts and records where it belongs. The invention, then, of such a scheme is something of utmost importance. It is a more important world problem than the aeroplane; but fewer, if any, inventors are working at it.

Classifying, indexing and preparing "revised" demands will be one of the most important and difficult subjects connected with this kind of accounting, and, in the larger cities at least, it will require especially trained and capable men.

This class of recording and accounting with its easily available detailed information is the very foundation for any system of cost keeping and sound financing. A thorough system of accounting—and this includes well segregated accounts—when compared with the single entry system of poorly segregated accounts still in use by most cities, ought to show a saving of at least $500 annually per thousand inhabitants, and, if to this is added a good system of budget making well carried out, in the course of several years the saving will, in my opinion, be equivalent to not less than $1,000 to $2,000 annually per thousand inhabitants. Furthermore, it will do much to bar incompetent and dishonest men from holding office, and it will inspire with confidence both the public official and the critical citizen.

Budget making as a fine art can hardly be comprehended until after the possibilities of such accounting as herein suggested have been discovered.

MUNICIPAL FINANCING.

By A. F. MACALLUM, *City Engineer, Hamilton, Ont.*

The subject which I have been requested to lay before you for consideration is that of Municipal Financing.

This subject is one which has not received the amount of attention such an important subject should have received by those who control the destinies of municipalities.

The keen competition in mercantile life has developed a system of accounting which gives the merchant a detailed insight into his smallest expenditure. This system has proven so beneficial that it is now being adopted by institutions and corporations, where a similar competition does not exist, but which through the very absence of competition, is even more so in need of analysis and as a result we now find municipalities adopting a uniform system of accounting, by means of which a thorough analysis is obtained of the expenditures of every branch of the service, the tabulation of which, for reference purposes, bids fair to revolutionize the whole system of municipal financing.

The revenue of the city is dependent upon the assessment, its development is dependent upon its revenue, and where the development is permitted to exceed the revenue, the department is confronted with the old familiar overdraft.

My observations have led me to the conclusion that overdrafts are largely due to inadequate data available from former years to properly estimate on proposed improvements or to provide adequate sums for regular annual maintenance charges.

With a view to overcome this undesirable condition in the city of Hamilton, in so far as it related to the works department, I instituted an entirely new system of accounting, the

one branch to deal with the general expenditures of the department, the other to deal with the unit costs of local improvements.

To fully understand the matter it will be necessary for me to explain that at the commencement of the year certain sums of money are appropriated for each item of expenditure required to operate each of the various branches of the department. Immediately that expenditures are incurred under these heads they are tabulated by the general accountant and at the close of each month a statement is placed before me, showing the amount appropriated and against this the amount expended to date. After the presentation of this statement, the engineer, foreman, clerk, or other officer having control over these items is called in to discuss with me any matters which may arise from this statement. In this manner a close watch is maintained on all expenditures and at the close of the year a comprehensive record is at hand on which to base the following year's requirements.

By the presentation of a second tabulation I have laid before me a comparative statement of what it costs each of the eight district foremen to maintain his portion of the city. Where any of the operations are similar in two or more of the districts a unit cost for comparative purposes is shown, the result has been that each of these men arrange their work thoroughly with a view to cheapen the costs. It is surprising to find how this has increased the efficiency of the labor cost and how much the system is approved of by the men, who now realize that some permanent record is preserved of their work.

The headings on this statement are: "Cost of Pavement Cleaning, Residence Section," "Cost of Pavement Cleaning, Business Section," "Roadway Repairs," "Roadway Gullies," "Street Watering," "Street Oiling," Macadam Roadways," etc., as shown on Form 1 following this paper. Form 1a is the form of daily report from which Form 1 is compiled.

The second system of accounting in connection with local improvement construction, known as the Unit Cost system, has

been most successful in its operations. The city undertakes by day labor the construction of sidewalks, curbs, sewers, roadways, as local improvements. Each of these kinds of work is divided into different units, which in the whole go to make up the actual cost of a work.

In the matter of roadways the headings are as follows (the city builds asphalt roadways only as local improvements): "Grading," "Concrete," "Binder," "Topping."

An order is issued to the foreman to construct an asphalt roadway on a certain portion of street, this order is made out in triplicate (Form 2 attached). Each work has an account number and a copy of order is sent to the accountant, one copy is retained in the office and the first copy given to the foreman. At the close of each day he makes a return of labor expended that day, the amount of material used together with any other information asked for on this form (see Form 3 attached). From this information which is handed to the cost accountant, a unit cost per foot is arrived at daily for each of the various segregations.

Form 4 gives summaries for week of all jobs.

Form 5 gives summaries for month of all jobs.

These tabulations are handed to the engineer-in-charge of roadway work and he is thus advised at once if any portion of the work is varying in cost.

These figures are used for comparative purposes thruout the entire season and monthly the foremen are sent copies of the unit cost of all the men on roadway work.

The same regulations apply to cement walk, sewer, miscellaneous, and water main construction (forms 2a, 2b, 2c, 2d, 3a, 3b, 3c, 3d, 4a, 4b, 4c, 4d, 5a, 5b attached).

As previously stated this system is productive of very gratifying results, we having overcome a great amount of labor loss and practically eliminated any leakage in supplies. This, coupled with the fact that each man is working for a record, has resulted in the department being able to construct works cheaper than before.

DAILY REPORT OF MATERIAL COST AND SUMMARY OF COST

Form 1

District No. ....191....

To W. C. Brennan, Secretary. .... Foreman

LIST OF MATERIALS	Unit	Pavement Repairs			General Roadway Repairs			Sidewalk Repairs			Crossing Repairs			STREET OILING								
														..........St			..........St			..........St		
														From..........			From..........			From..........		
														To..........			To..........			To..........		
		No.	Price	Amt.	No.	Price	Amt.	No.	Price	Amt.	No.	Price	Amt.	No.	Price	Amt.	No.	Price	Amt.	No.	Price	Amt.
Sand	Load																					
Gravel	Load																					
Cement	Sacks																					
Stone from Quarry	Load																					
Stone Bought	Load																					
Screenings	Load																					
Brick	No.																					
Road Oil	Gal.																					

SUMMARY OF COST

Pavement Cleaning Business District	Total Last Date. Labor This Date Material This Date. Cost to Date.			Average Cost Per Sq. Yd.	Sidewalks Repairs	Total Last Date. Labor This Date Material This Date Cost to Date.			Average Cost per Sq. Ft.
Pavement Cleaning Residence District	Total Last Date. Labor This Date. Material This Date Cost to Date.			Average Cost Per Sq. Yd.	Crossing Repairs	Total Last Date. Labor This Date. Material This Date. Cost to Date.			Average Cost Per Sq. Ft.
Pavement Repairs (Concreting)	Total Last Date. Labor This Date Material This Date Cost to Date.			% of Labor Material	Cutting Weeds City Property	Total Last Date. Labor This Date. Material This Date. Cost to Date.			Total Cost Only

Form 1 (Continued)

Cleaning Gully Drains Cleaned Last Date Cleaned This Date Total	Total Last Date Labor This Date Material This Date Cost to Date			Average Cost Per Drain	Cutting Weeds Private Property	Total Last Date Labor This Date Material This Date Cost to Date			Total Cost Only
General Street Cleaning Loads Last Date Loads This Date Total	Total Last Date Labor This Date Material This Date Cost to Date			Average Cost Per Load	Street Watering Loads Last Date Loads This Date Total	Total Last Date Labor This Date Material This Date Cost to Date			Average Cost Per Load
General Snow Cleaning	Total Last Date Labor This Date Material This Date Cost to Date			Total Cost Only	Street Oiling Sweeping	Total Last Date Labor This Date Material This Date Cost to Date			Average Cost Per Sq. Yd.
Snow Cleaning Private Property	Total Last Date Labor This Date Material This Date Cost to Date			Total Cost	Oiling	Total Last Date Labor This Date Material This Date Cost to Date			Average Cost Per Sq. Yd.
Sanding Sidewalks	Total Last Date Labor This Date Material This Date Cost to Date			% Labor of Material	Placing Screenings	Total Last Date Labor This Date Material This Date Cost to Date			Average Cost Per Sq. Yd.
General Roadway Repairs	Total Last Date Labor This Date Material This Date Cost to Date			% Labor of Material	Road Roller	Total Last Date Labor This Date Material This Date Cost to Date			Average Cost Per Sq. Yd.
Street Grading or Rounding	Total Last Date Labor This Date Material This Date Cost to Date			Total Cost Only	Summary of Street Oiling	Total Cost Oiling Sq. Yds. Oiled Avg. cost per Sq. Yd			

WORKS DEPARTMENT DAILY REPORT OF LABOR AND MATERIAL Form 1 A

District No.................... ....191....

....Foreman

Number of Laborers Employed..... . . . . — Total Hours all Labor. . . . .

Number of Teams Employed .... — Total Hours all Teams.. . . . .

Number of Hours Worked A. M.... .... — Weather Conditions, A. M. . . . .

Number of Hours Worked P. M.................. .... — Weather Conditions, P. M... ....

Total Cost of Labor, Teams, Foreman and Timekeeper, $ . ...

DISTRIBUTION OF LABOR AND MATERIAL

REGULAR ACCOUNTS	LABOR AND MATERIALS: Unit										STREET OILING	LABOR and MATERIALS: Unit				
		L'd	L'd	S'k	L'd	L'd	L'd	No.					L'd	L'd	L'd	L'd
	LABOR	Sand	Gravel	Cement	Stone From Quarry	Stone Bought	Screenings	Brick				LABOR	Road Oil	Screenings	Stone From Quarry	Stone Bought
Pavement Cleaning, Business District. . . .											.... St.					
Pavement Cleaning, Residence District. . . .											From........					
Pavement Repairs											To.					
Cleaning Gully Drains.. . .	Number										Sweeping.........					
General Street Cleaning.....	No. Loads										Oiling....					
General Snow Cleaning..											Placing Screenings					
Snow Cleaning, Private Property .											Road Roller......					
Sanding Sidewalks											.... St.					
General Roadway Repairs.......											From.....					
Street Grading or Rounding.......											To................					
Sidewalk Repairs......................	No. Sq. Ft.										Sweeping....					

Form 1 A (Continued)

No. Sq. Ft.											
Crossing Repairs											
Cutting Weeds—City Property											
Cutting Weeds—Private Property No. Loads											
Street Watering											
SPECIAL ACCOUNTS											
Total.											

REMARKS.

Oiling.						
Placing Screenings.						
Road Roller						
St.						
From						
To						
Sweeping						
Oiling.						
Placing Screenings.						
Road Roller						
St.						
From						
To						
Sweeping						
Oiling.						
Placing Screenings.						
Road Roller						
St.						
From						
To						
Sweeping						
Oiling.						
Placing Screenings.						
Road Roller						
Total Street Oiling.						

NOTE—This report must be in secretary's office not later than nine o'clock of the following day.

WORKS DEPARTMENT — Form 2, First Page

FOREMAN'S WORKS ORDER

Original — *City Hall, Hamilton* 191

Mr.

You are hereby instructed to

Charge to

Account No.

Requisition No.

This order to be returned when work is completed, with labor and materials used filled in on back hereof, and the material transferred filled in on credit memo attached.

..............................Secretary

(Carbon duplicate of this original (first page) is marked "stores copy." Carbon triplicate of this original (first page) is marked "office copy." Original yellow paper 8½ by 11-inch page.)

Form 2, Second Page — *Hamilton,* 191

The following is a correct return of Labor and Materials expended on Work specified on other side hereof.

Quantity		Office Use Only		
		Price	Amount	
....	Labor.......	....	....	.....
....	Material	....	....	.....
....	....	....	....	.....

Commenced....................191

Completed....... 191

Certified Correct

..............................Foreman

(Fourth Page is blank) ....Timekeeper

CREDIT MEMO

Form 2, Third Page

Hamilton, ...191

	Voucher No.	Amount	Ledger
The following Materials have been transferred to Account No.........	....	....	....

Location..................................St. From..........................To......................

ARTICLE	Size	Unit	Quantity	Office Use Only		ARTICLE	Size	Unit	Quantity	Office Use Only	
				Price	Amt.					Price	Amt.
Asphalt						Bro't For'd					
Cement						Sewer Pipe Bends					
Coal						Sewer Pipe Bends					
Coke						Sewer Pipe Junctions					
Gravel						Sewer Pipe Stops					
Gully Grates						Sewer Pipe Traps					
Jute						Stone from Quarry					
Lead						Stone Bought					
Lumber	1″	P B Mse				Screenings					
Lumber	2″	″				Stone Dust					
Lumber	3″	″				Tie Rings					
Lumber	4″	″				Track Grates					
Lumber	6″	″				Water Main Pipe					
Lumber	8″	″									
Round Posts											
Paving Blocks											
Paving Brick											
Sand											
Sewer Pipe											
Sewer Pipe											
For'd									Total		

Credit To
Account No.

Voucher No.	Amount	Ledger
....	....	....

Certified Correct

..............................Foreman

Requisition No. ....Timekeeper

These forms are far reaching in their effectiveness and space will not permit me to go into details, but we now know absolutely what it costs to produce a load of asphalt, and how many yards are laid to the load. We can tell at a glance how many bags of cement each foreman uses in a given yardage of foundation, how many bags are delivered on a work, how much is used and where the balance is transferred. In short, by a careful use of all the forms there is not a cost, or other information as to supplies that cannot be arrived at.

I cannot speak too highly of the success of this plan. I have brought a complete set of the forms which are herewith submitted, which include receipt book for deliveries of sand, gravel, stone and other supplies (forms 6, 7 and 8), and I can assure any person who desires to adopt a plan similar to this one, that as the possibilities are unfolded they will become enthusiastic supporters of the system.

This method has made the financing of the works end very simple, but there are problems confronting other branches of municipal control, which require considerable study. Let me refer to one item of serious loss to a municipality. I refer to the sale of its bonds, which is invariably carried out at a sum below par. This item alone amounts to a very serious loss of revenue annually to the average municipality.

It would seem to me that the government might establish a municipal department which would have direct control over municipalities and which, if conditions were found to be satisfactory, might guarantee the municipalities bond issue and practically assure its sale at par and save these corporations the sums lost annually through ficticious possibilities.

In conclusion let me say that it appears to me that much better results financially could be obtained for municipalities if its control were placed in the hands of a permanently appointed head or heads, whose life's work had been spent in municipal work rather than having its destinies shaped by an elective body whose policies change with the change of its personnel.

Form 2a for "Cement Walks," is same as Form 2, except that paper is pink.

Form 2b for "Sewers," is same as Form 2, except that paper is orange.

Form 2c for "Miscellaneous Construction," is same as Form 2, except that paper is white.

Form 2d for "Water Main Construction," is same as Form 2, except that paper is green.

Form 3a for "Cement Walks," is same as Form 3 except that the paper is pink; on first page items in column headed "Operation," are "Grading," "Curb and Form Setting," "Foundation," "Concreting," "Sundries," unit is fixed as sq. ft.; and on second page headings of columns of upper table are "Foundation," "Concreting," "Sundries"; and items in column "List of Material" are "Stone from Quarry, loads," "Stone bought, loads," "Cinders, loads," "Slag, loads," "Gravel, loads," "Beach Sand, loads," "Cement, sacks," "Tie Rings, No.," "Coal Oil, gal.," "Coal, lbs."; and headings of columns of lower table are same as items in column headed "Operation" on first page, as given above.

Form 3b for "Sewers," is same as Form 3 except that the paper is orange; on first page items in column headed "Operation," are "Excavating," "Drilling and Blasting," "Shoring," "Pumping," "Pipe Laying," "Refilling," "Removing Earth," "Manholes," "Gullies," "Sundries"; and on second page headings of columns of upper table are "Drilling and Blasting," "Pipe Laying," "Manholes," "Gullies," "Sundries"; and items in column headed "List of Material," are "Dynamite, lb.," "Fuse, 4-ft., no.," "Fuse, 6-ft., no.," "Pipe, ft." (twice), "Junctions, no.," (twice), Bends, no.," (twice), "Traps, no.," "Manhole Cover, no.," "Steps, no.," "Gully Cover. no.," "Cement, sack," "Sand, load," "Gravel, load"; and headings of columns in lower table are same as items in column headed "Operation" on first page, as given above.

Form 3c for "Miscellaneous Construction," is same as Form 3, except that paper is white; on first page "Kind of Work" is

Form 3, First Page

Works Department Daily Report of Labor

To City Engineer.................................Hamilton..............191....

Number of Laborers Employed...... . . Total Hours of all Labor............ .

Number of Teams Employed.......... Total Hours of all Teams.............

Number of Hours Worked A. M.... ... Weather Conditions A. M...... ......

Number of Hours Worked P. M... .... Weather Conditions P. M........ ....

Total Cost of Labor, Teams, Foreman and Timekeeper, $.........

Kind of Work — Account No............. — Date Completed....... ..

.... Location .... . . .St.

... .Foreman

From..... . ...

....

To........ ....Timekeeper

DISTRIBUTION OF LABOR					REMARKS
Operation	Unit	Completed	Labor		
Grading.					
Concreting.....					
Binders					
Topping.					
Hauling Blocks.					
Hauling Stone ..					
Block Laying...					
Squeegee Coat.					
Sundries......					
....					
....					

Total Labor

Material Report and Cost Summary on Back of Sheet.

DAILY REPORT OF MATERIAL AND SUMMARY OF COST

DISTRIBUTION OF MATERIAL Form 3, Second Page

..............................191....

LIST OF MATERIAL	Unit	CONCRETING		
		No.	Price	Amt.
Stone from Quarry	Loads			
Stone Bought	Loads			
Gravel	Loads			
Sand	Loads			
Cement	Sack			
Blocks	Sq. Yd.			
Binder	Loads			
Topping	Loads			
Screenings	Loads			
Stone Dust	Lb.			
Asphalt	Lb.			
Coal	Ton			
Coke	Ton			
Wood	Cord			
Totals				

First group of three columns under "Concreting" is given here in full. Headings of the other groups are "Binder," "Topping," "Block Laying," "Squeegee Coat" "Sundries," with a "Grand Total."

SUMMARY OF COST

UNIT OF MEASURE	Sq. Yds.	
PARTICULARS	Grading	
Labor Cost Last Date		
Labor Cost This Date		
Labor Cost To Date		
Material Cost Last Date		
Material Cost This Date		
Material Cost To Date		
Total Cost To Date		
Completed Last Date		
Completed This Date		
Completed To Date		
Avg. Cost To Date		
Estimated Cost		
Differences		

First column headed "Grading" is shown. Headings of the other columns are "Concreting," "Binder," "Topping," "Hauling Blocks," "Hauling Stone," "Block Laying," "Squeegee Coat," "Sundries," all with square yards as unit of measure; and "Grand Total."

replaced by "Brick Crossing, width of St., width of crossing"; items in column "Operation" are "Grading, sq. ft.," "Foundation, sq. ft.," "Laying Brick, sq. ft.," "Sundries, sq. ft."; and on second page headings of columns of upper table are "Foundation," "Laying Brick," "Sundries"; items in column "List of Material" are "Stone from Quarry, loads," "Stone Bought, loads," "Sand, loads," "Gravel, loads," "Cement, sack," "Paving Brick, no.," "4x4 Pine, linear ft.," "Coal Oil, gal"; and headings of columns of lower table are same as items in column "Operation," on first page, as given above.

Form 3d for "Water Main Construction," is same as Form 3, except that paper is green; on first page items in column "Operation" are "Excavating, cu. yds.," "Shoring, ft.," "Pumping," "Pipe Laying and Calking," "Valve Chambers and Valve Setting," "Setting Hydrants," "Refilling," "Removing Earth," "Sundries"; and on second page headings of columns of upper table are "Pipe Laying and Calking," "Valve Chambers and Setting Valves," "Setting Hydrants," "Sundries"; items in column "List of Material" are "Pipe, ft.," "Lead, lb.," "Jute, lb.," "Valve, no.," "Valve Cover, no.," "Hydrant, no.," "3-way, no.," "Sleeve, no.," "Sand, load," "Gravel, load," "Stone from Quarry, load," "Stone Bought, load," "Cement, sack," "Coke, ton"; and headings of columns of lower table are same as items in column "Operation" on first page as given above.

Form 4a for "Cement Walks," is same as Form 4 except that the paper is pink and the items in upper table in column "Operation" are "Grading," "Curb and Form, Setting," "Foundation," "Concreting," "Sundries"; the headings of the columns in the lower table are "Foundation," "Concreting," "Sundries"; and the items in the column "List of Material" are the same as in that column in Form 3a, second page.

Form 4b for "Sewers," is same as Form 4 except that the paper is orange and the items in upper table in column "Operation" are same as in like column on first page of Form 3b; the headings of the columns in lower table are "Drilling and

Form 4

Daily Distribution of Labor and Material, Week Ending.......... ....191....

Kind of Work........................ **Account No... .. ..**

Location....... ... ., ... **Foreman .. ..**

OPERATION	Unit	TUESDAY	
		Completed	Labor
Grading	Sq. Yds.		
Concreting	Sq. Yds.		
Binder	Sq. Yds.		
Topping	Sq. Yds.		
Hauling Blocks	Sq. Yds.		
Hauling Stone	Sq. Yds.		
Block Laying	Sq. Yds.		
Squeegee Coat	Sq. Yds.		
Sundries	Sq. Yds.		
Totals			

First group of columns headed "Tuesday" is given in full. The other groups are headed "Wednesday", "Thursday", "Friday", "Saturday", "Monday" with a column "Grand Total".

LIST OF MATERIAL	UNIT	Concreting	Binder	Topping	Block Laying	Squeegee Coat	Sundries
Stone from Quarry	Load						
Stone Bought	Load						
Gravel	Load						
Sand	Load						
Cement	Sack						
Blocks	Sq. Yds.						
Binder	Load						
Topping	Load						
Screenings	Load						
Stone Dust	Load						
Asphalt	Lb.						
Coal	Ton						
Coke	Ton						
Wood	Cord						

WORKS DEPARTMENT

Form 5

ROADWAYS CONSTRUCTION

Cost Statement of Construction Work Completed Month Ending Aug. 31st, 1914.

Particulars	Account No.	Street	Side	Streets Between	Area	Operations and Cost of Each, Per Unit: Grading	Concreting	Binder	Topping	Asp. Mac.	Squee. Ct.	Sundries	Total Cost Per Unit	Total Cost
Asphalt	14281	Prospect		King-Main	3724	0739	.[illegible]	.3786	.4975			.0088	1.6127	6022.16
Estimate					3653	.2500	.[illegible]	.4500	6500				2.2000	8036.60
Differences					(71)	1761	[illegible]	.0764	.1525			(.0088)	.5873	2014.44
Asphalt	14291	Norway		Maple-Cumberland	2319	.1196	.6781	.3494	5277			.0056	1.6804	3898.94
Estimate					2358	.2500	.8500	.4500	.6500				2.2000	5187.60
Differences					39	.1304	.1719	.1006	.1223			(.0056)	.5196	1288.66
Macadam	14311	Inglewood Drive		James-Bay	2624	.1346	.7239	3217		.5123		.0163	1.7088	4536.61*
Estimate					2720								2.0000	5440.00
Differences					96							(.0163)	.2912	903.39
Asphalt	14331	Dunsmure		Sherman-Carrick	2470	.1064	.6702	.3902	.4946			.0104	1.5716	4134.77†
Estimate	14341				2617									5240.07
Differences					147							(.0104)		1105.30
Asphalt	14301	Spadina		King-Main	3977	.1249	.6406	.3247	4737			.0139	1.5778	6274.81
Estimate					3950	.3000	.8500	.4500	.6500				2.2500	8887.50
Differences					(27)	.1751	2094	1253	.1763			(.0139)	6722	2612 69
Asphalt	14321	Leinster		King-Main	3535	0598	[illegible]	.3693	.5063			.0233	1.6201	5727 60
Estimate					3493	.2500	.[illegible]	.4500	.6500				2.2000	7684 60
Differences					(42)	.1902	.[illegible]	.0807	.1437			(.0233)	.5799	1957 00
Asphalt	14461	Barnesdale		King-Dunsmure	2460	.1109	.7103	3080	.5177			.0172	1.6641	4081 35
Estimate					2571	2500	8500	.4500	.6500				2.2000	5656.20
Differences					111	.1391	1397	.1420	.1323			(.0172)	.5359	1574.85
Asphalt	14361	Kent		Aberdeen-B & H.	1168	.1768	6580	.3901	5000			.0244	1.7443	2080.94
Estimate					1173	.3000	.8500	.4500	.6500				2.2500	2689.25
Differences					5	.1132	1970	0599	1500			(.0244)	.5057	608.31
Asphalt	14371	Sophia		King-Main	2199	.2482	.[illegible]	.3631	.4927			.0126	1.7790	3911.78
Estimate					2213	.3000	.[illegible]	.4500	.6500				2.2000	4868.60
Differences					14	.0518	.[illegible]	.0869	.1573			(.0126)	.4210	956.82

* Squeegee coat included in cost of Macadam—3,002 yds. of Grade not segregated.
† 2,537 yds. Grade. This order was made out under two numbers—not segregated.

WORKS DEPARTMENT

Form 5 (Continued)

ROADWAYS CONSTRUCTION

Cost Statement of Construction Work Completed Month Ending Aug. 31st, 1914.

Particulars	Account No.	Street	Side	Streets Between	Area	Operations and Cost of Each, Per Unit: Con-creting	Under Pinning						Total Cost Per Unit	Total Cost
Brick Gutter	14161	Stanley	B	Locke-Garth	63	72.24							1.15	72 24
Estimate														
Differences														
Cement Gutter	14271	John	S	Barton-Murray	133	184.93							1.39	184.93
Estimate														
Differences														
Cement Gutter	14331-41	Dunsmure		Sherman-Carrick	67	121.90							1.82	121.90
Estimate														
Differences														
Cement Gutter	14461	Barnesdale		King-Dunsmure	60	77.72							1 29	77.72
Estimate														
Differences														
Underpinning	14471	N. Rosemont		Barnesdale-End of P.	145		25.29						.1744	25.29*
Estimate														
Differences														
Cement Gutter	14481	Carrick		King-Dunsmure	138	171 03							1.24	171.03
Estimate														
Differences														
Cement Gutter	14501	Barnesdale		King St. northerly	109	165.15							1.51	165.15
Estimate														
Differences														
Cement Gutter	14541	Balsam		King-Maple	35	31.18							.89	31.18
Estimate														
Differences														

* Underpinning on Cement Walk.

WORKS DEPARTMENT

Form 5A

CEMENT WALK AND CURB CONSTRUCTION

Cost Statement of Construction Work Completed Month Ending Aug. 31st, 1914.

PARTICULARS	Account No.	Street	Side	Streets Between	Area	Operations and Cost of Each, Per Unit: Grading	Curb and Form Set	Foundation	Concreting	Sundries	Total Cost Per Unit	Total Cost
Cement Walk and Curb	10311	King	N.	Gage Ave.-130' E.	9124	0168	.0063	.0478	.1148	.0069	.1926	*1757.63
Estimate		W. J. Carter		of Garfield	13750	.0327	.0155	.0546	1336	......	2864	3250.00
Differences					4626	.0159	0092	.0068	.0188	(0069)	.0438	1492.37
Cement Walk and Curb	10801	Avalon Place	S.	Burris-Arthur	2478	.0210	.0087	.0393	.0756	.0060	.1506	373.50
Estimate		John Smith			4920	.02	.01	04	.09	....	16	787 20
Differences					2442	(.0010)	.0013	.0007	.0144	(.0060)	.0094	413.70
Cement Walk and Ind. Curb	11021	Birch Ave.	E.	Burlington to S.	3550	.0248	.0054	.0206	.0874	.0088	.1420	†503.71
Estimate		W. Madden		Limit of Lot 10	2750	02	.01	04	.09	......	16	440.00
Differences					(800)	(0048)	.0046	.0194	.0026	(.0088)	.0180	(63 71)
Cement Walk and Curb	11041	Macullum	B.	Wentworth-Wilfrid	7680	.0088	.0042	.0275	.0835	.0019	.1259	966.73
Estimate		W. Madden			7680	.02	.01	.04	09	......	.16	1228.80
Differences						.0112	.0058	.0125	.0065	(0019)	.0341	262.07
Cement Walk and Curb	11081	Alpine	N.	End of walk W. of Wentworth to present walk	6810	.0080	.0064	.0823	.0981	.0009	.1407	958.48
Estimate		John Smith			7200	02	.01	04	.09	....	.16	1152 00
Differences					0390	.0120	.0036	.0077	(.[illegible])	(0009)	.0193	193.52
Cement Walk and Curb	11121	Dalkeith	B.	Ottawa-Rosslyn	9840	0097	0080	.0368	.0823	0009	1327	1306.22
Estimate		Smith-Ferris			9840	.02	.01	.04	.09	....	.16	1574.40
Differences						.0103	.0070	0032	.0077	.0009	.0273	268.18
Cement Walk and Curb	11131	Dalhousie	S.	Ottawa-Rosslyn	4920	.0137	0036	.0700	0868	.0007	.1748	**859.69
Estimate		Smith-Ferris			4920	.02	01	04	.09	....	.16	787.20
Differences						.0063	.0064	(.0300)	.0032	(0007)	(.0148)	(72 49)
Cement Walk and Curb	11151	Mountain Park R.	B.	End of walk W. to end of street	3180	.0165	.0071	.0257	.0982	.0015	.1440	458.70
Estimate		John Smith			3000	.02	.01	.04	.09	....	.16	480.00
Differences					(180)	.0035	.0029	.0143	(.0082)	(.0015)	.0160	21.30
Cement Walk and Curb	11161	Oliver	S.	Wentworth-Wilfrid	3000	.0168	.0044	.0394	.0839	.0023	.1468	440 06
Estimate		W. Madden			3900	.02	.01	.04	.09	....	.16	624 00
Differences					900	0032	.0056	.0006	.0061	(.0023)	.0132	183.94

** Foundation heavy   † Entire job not completed—cost of work to date.   * Work will be completed next year.

WORKS DEPARTMENT

Form 5A (Continued)

CEMENT WALK AND CURB CONSTRUCTION

Cost Statement of Construction Work Completed Month Ending Aug. 31st, 1914.

PARTICULARS	Account No.	Street	Side	Streets Between	Area	Operations and Cost of Each, Per Unit: Grading	Curb and Form Set	Foundation	Concreting	Sundries	Total Cost Per Unit	Total Cost
Cement Walk and Curb	11361	Lottridge	E.	Barton-First Ave.	2340	0212	.0053	0463	0848	.0019	.1605	375 86
Estimate		Smith-Ferris			2340	.02	.01	.04	.09	...	.16	374.40
Differences						(.0012)	.0037	(.0063)	.0052	(.0019)	(.0005)	(1 46)
Cement Walk and Curb	11381	Belmont	W.	Cannon-King	7800	.0155	.0052	.0455	0591	.0032	.1285	1002 97
Estimate		Smith-Ferris			10020	.02	.01	.04	.09		.16	1603.20
Differences					2220	.0045	0048	(.0055)	0309	(0032)	.0315	600 23
Cement Walk and Curb	11401	Ellis	E.	Barton-Britannia	6960	0185	.0048	0259	.0897	.0046	.1435	998 80
Estimate		Smith-Ferris			6960	.02	.01	.04	.09		.16	1113.60
Differences						0015	.0052	0141	.0003	(.0046)	.0165	114 80
Cement Curb	10981	Barnesdale	B.	Dunsmure-King	1806	0166	.0137	0746	.12414	.0048	.3511	634 65
Estimate		Carter-Cranston			1800	.07	.03	.08	24		.42	756.00
Differences					(6)	.0534	0163	0054	(.0014)	(.0048)	.0689	121.35
Cement Walk and Curb	11411	Gertrude	N.	End of present walk to Lot No. 10	1440	.0123	.0037	0643	.0880	0006	.1689	243.20
Estimate		Smith-Ferris			1440	.02	.01	.04	.09		16	230.40
Differences						0077	.0063	(0243)	0020	(.0006)	(.0089)	(12.80)
Cement Walk and Curb	11421	London	E.	Edinburgh-Cannon	2760	.0250	.0040	0184	0796	0006	.1276	351.93
Estimate		Smith-Ferris			2760	.02	.01	04	09		16	441.60
Differences						(0050)	0060	.0216	.0104	(0006)	.0324	89.67
Cement Walk and Curb	11431	Munroe	N.	Wentworth-Niagara	1980	.0055	0033	.0238	0816	0007	.1149	227 67
Estimate		W. Madden			1980	02	.01	.04	.09		16	316 80
Differences						.0145	.0067	0162	.0084	(.0007)	.0451	89.13
Cement Walk and Curb	11441	Roxboro	N.	Belmont to 1st alley east	720	.0070	.0104	.0916	.0980	0009	.2079	149.68
Estimate		Smith-Ferris			720	.02	01	04	.09		.16	115 20
Differences						0130	(.0004)	(0516)	(.0080)	(.0009)	(.0479)	(34 48)
Cement Walk and Curb	11451	Short	E.	Beach Rd. to GTR Tracks	1200	0021	.0042	.0302	.0793	0015	.1173	140 69
Estimate		Smith-Ferris			1200	.02	.01	04	.09		.16	192.00
Differences						.0179	.0058	.0098	.0107	(.0015)	.0427	51.31

WORKS DEPARTMENT

Form 5A (Continued)

CEMENT WALK AND CURB CONSTRUCTION

Cost Statement of Construction Work Completed Month Ending Aug. 31st, 1914

PARTICULARS	Account No.	Street	Side	Streets Between	Area	Operations and Cost of Each, Per Unit: Grading	Curb and Form Set	Foundation	Concreting	Sundries	Total Cost Per Unit	Total Cost
Cement Walk and Curb	11491	First	S.	Gage Ave.-Chappell	3960	.0086	.0034	.0464	.0886	.0063	.1533	606.63
Estimate		W. J. Carter			4200	.02	.01	.04	.09		.16	672.00
Differences					240	.0114	.0066	(.0064)	.0014	(.0063)	.0067	65.17
Cement Walk	11501	Ottawa	E.	Cannon-Main	9218	.0189	.0047	.0577	.0747	.0018	.1578	1450.25
Estimate		Smith-Ferris			9900	.05	.01	.05	.09		.16	1782.00
Differences					682	.0111	.0053	(.0077)	.0153	(.0018)	.0227	331.75
Cement Curb	11521	Jackson	B.	John-Catharine	620	.0371	.0174	.0443	.1876	.0426	.3290	204.03
Estimate		John Smith			640	.07	.03	.08	.24		.42	268.80
Differences					20	.0329	.0126	.0357	.0524	(.0426)	.0910	64.77
Cement Walk and Curb	11541	Palmerston	B.	Beach Rd.-Gertrude	6750	.0118	.0043	.0325	.0824	.0022	.1882	899.48
Estimate		Smith-Ferris			6360	.02	.01	.04	.09		.16	1017.60
Differences					(390)	.0082	.0057	.0075	.0076	(.0022)	.0268	116.12
Cement Walk and Curb	11551	Nightingale	S.	Wentworth to end of street	2640	.0061	.0053	.0297	.0617	.0159	.1407	367.11
Estimate		John Smith			2640	.02	.01	.04	.09		.16	826.40
Differences						.0119	.0047	.0103	.0083	(.0159)	.0193	39.29
Cement Walk and Curb	11561	Whitfield	S.	Birmingham-Gage	5400	.0182	.0041	.0215	.0907	.0063	.1408	750.45
Estimate		Smith-Ferris			5400	.02	.01	.04	.09		.16	864.00
Differences						.0018	.0059	.0185	(.0007)	(.0063)	.0192	113.55
Cement Walk and Curb	11571	Beulah	E.	South to end of street	2400	.0052	.0057	.0428	.0752	.0027	.1316	315.84
Estimate		John Smith			2400	.02	.01	.04	.09		.16	384.00
Differences						.0148	.0043	(.0028)	.0148	(.0027)	.0284	68.16

WORKS DEPARTMENT

Form 5A (Continued)

CEMENT WALK AND CURB CONSTRUCTION

Cost Statement of Construction Work Completed Month Ending Aug. 31st, 1914.

PARTICULARS	Accum No.	Street	Side	Streets Between	Area	Operations and Cost of Each, Per Unit: Grading	Curb and Form Set	Foundation	Concreting	Sundries	Total Cost Per Unit	Total Cost
Cement Walk and Curb	11581	Chapple	W.	First Ave. to 120'	840	.0071	.0059	.0356	0888	.0018	1387	116 60
Estimate		Smith-Ferris		northerly	840	02	.01	.04	09		.16	134.40
Differences						.0129	0041	0044	.0017	(0018)	.0213	17.80
Cement Walk and Curb	11591	Mary	E.	Burlington to end of walk N. of Wood St	1200	.0167	.0058	.0487	.0904	.0133	.1749	209.93
Estimate		Smith-Ferris			1200	.02	.01	.04	.09		16	192 00
Differences						.0033	0042	(.0087)	(.0004)	(.0133)	(.0149)	(17.93)
Cement Walk and Ind. Curb	11621	Sherman	W.	Main-Delaware	4680	.0131	.0106	.0579	.0923	0097	.1836	858.87
Estimate		W. Madden			4680	.0327	.0155	.0546	.1336		.2364	936 00
Differences						.0196	.0049	(.0033)	.0413	(0097)	.0528	77.13
Cement Walk and Curb	11631	Beulah	N.	South to end of street	2400	.0202	.0057	.0226	.0773	.0039	.1299	311.61
Estimate		J. Smith			2400	.02	01	04	.09		.16	384.00
Differences						(.0002)	0043	.0172	.0127	(0039)	.0301	72.39
Cement Walk and Curb	11641	Kent	N.	B & H Ry.-end of walk southerly	762	0083	0071	.0449	.0614	.0350	.1567	119.41
Estimate		J. Smith			660	.02	.01	.06	.09		.18	118 80
Differences					(102)	.0117	.0029	.0151	.0286	(.0350)	.0233	(61)
Cement Walk and Curb	11661	Birmingham	W.	T H & B Spur to Burlington	6000	.0207	.0069	.0429	.0888	.0078	.1671	1002.71
Estimate		Smith-Ferris			6500	.02	.01	.04	.09		.16	1040.00
Differences					500	(.0007)	.0031	(.0029)	.0012	(.0078)	(.0071)	37.29
Cement Curb	18101-13	Ferguson	E.	King Wm.- Southerly	52	0096	.0104	.1817	.2140	.0596	.4753	*24.72
Estimate		John Smith										

* 1913 Estimate

WORKS DEPARTMENT

Form 5B

SEWERS CONSTRUCTION

Cost Statement of Construction Work Completed Month Ending Aug. 31st, 1914.

Particulars	Account No.	Street	Side	Streets Between	Area	Operations and Cost of Each, Per Unit: Excavating	Dr. and Bl.	Shoring	Pipe Laying	Refill. and R. Earth	Manholes, Gullies	Sundries	Total Cost Per Unit	Total Cost
15" Sewer	16141	Main		James-McNab.	428	.5519	0	0	6707	76.75	25.38	24.00	1.891	*809.49
Estimate					420	.8000	0	50.00	.6447	210 90	60.00		2 652	1114 05
Differences					(8)	.2481	0	50.00	(0260)	134.15	34.62	24.00	.761	304 56
12" Sewer	16171	Burris.		Cumberland-H. G. & B	271	.4778	8031	0	.5783	1068	68 26	27.21	1.62	440 39
Estimate					210	.6000	0	17.50	.4160	.7000	104.00		1 82	383 80
Differences					(61)	12.32	(.8031)	17.50	(.1623)	5932	35 74	(27 21)	.20	(56 59)
Estimate														
Differences														
Estimate														
Differences														
Estimate														
Differences														
Estimate														
Differences														
Estimate														
Differences														

* One manhole installed

Serial No. STONE TICKET. **Form 6**

Hamilton..............................191...

FOREMAN CITY QUARRY:

Please Supply Stone as below specified,

to be used for

Account No..

District No..

....St. ....Side

From.............................. To...............................St.

...........................Driver ....Foreman

Kind Wanted	Owner of Team	Time Left Quarry	Checker's Initials	Time Received	Received by

NOTE—Teams MUST have this ticket initialed at quarry and at place delivered and return to foreman for which work was done, when last load for the day is delivered.

Foreman MUST preserve this ticket and return same with Foreman's Work Order as voucher for stone used on job.

FOREMAN'S COPY

Serial No. STONE TICKET. **Form 7**

Hamilton,.........:.. ....191...

Canada Crushed Stone Corporation, Ltd., HAMILTON YARD

Please Supply Stone as below specified, to be used for

Account No............ District No............

...............................St. From..............................St.

To..............................St.

..................................Teamster

.......................Owner of Team.......................Foreman

Kind Wanted	Net Weight	Checker's Initials	Time Received	Received by

NOTE—Teamsters MUST have this ticket initialed at yard and place delivered and return to Foreman for which work was done when last load for day is delivered.

Foreman MUST preserve this ticket and return same with Foreman's Work Order as voucher for stone ordered and used on job.

FOREMAN'S COPY.

GRAVEL RECEIPT **Form 8**

WORKS DEPARTMENT—CITY OF HAMILTON

This Load Inspected

Quantity (54 Cubic ft.) and Quality Correct

Date.................... Inspector....................

Date.............................

Received from Contractor..

per Teamster ....

One Load of 54 Cubic ft. of Gravel

For..........................Side of............................Street

From........................Street to..........................Street

Account No..................... **Serial No.**

....Foreman

CONTRACTOR'S COPY

Blasting," "Pipe Laying," "Manholes," "Gullies," "Sundries"; and the items in the column "List of Material" are the same as in like column in Form 3b, second page.

Form 4c for "Miscellaneous Construction," is same as Form 4 except that the paper is white and the items in upper table in column "Operation" are same as in like column on first page of Form 3c; the headings of the columns in lower table are "Foundation," "Laying Bricks"; and the items in the column "List of Material" are the same as in like column in Form 3c, second page, with addition of "Asphalt Filler, lbs."

Form 4d for "Water Main Construction," is same as Form 4 except that the paper is green, and the items in upper table in column "Operation" are same as in like column on first page of Form 4c; the headings of the columns in lower table are "Pipe Laying and Calking," "Valve Chambers and Setting Valves," "Setting Hydrants," "Sundries"; and the items in the column "List of Material" are the same as in like column in Form 4c, second page.

Backs of originals and duplicates of Forms 6, 7 and 8 are carboned and they are printed and folded so that writing the original makes the carbon duplicate and triplicate, which are then torn apart. The original is the "Foreman's Copy" of Forms 6 and 7 and the "Contractor's Copy" of Form 8. The duplicate is the "Permanent Copy" of Forms 6 and 7 and "Inspector's Copy" of Form 8. The triplicate is the "Quarry Copy" of Form 6, the "Yard Copy" of Form 7 and the "Foreman's Copy" of Form 8.

Forms 6 and 8 are printed on white paper; Form 7 on yellow paper. The original is written in pencil and the duplicate is a carbon, both printed in black. The triplicate is a carbon and is printed in red, so that the three can be distinguished even without the line at the bottom stating whose copy each is.

LIMITATIONS OF WATER FILTERS.

By George W. Fuller, *New York City.*

The modern water filter has been so markedly successful in its service of purifying water supplies for domestic purposes that it has sometimes been taken to be a cure-all for any ills or unfortunate conditions which might affect the water. A water might be turbid enough to make it almost a liquid mud. It might be so badly polluted by bacteria that it is not much better than a weak sewage effluent. It might have such a strong color that it could easily pass at a soda-water fountain, or would make a very strong circus lemonade. In all such cases, it has often been taken as a matter of course that the addition of an ordinary water filter either of the slow sand type or the mechanical type would be sufficient to bring the water to a condition of perfect purity in all its properties and make it absolutely satisfactory and sufficient for all drinking purposes.

Limitations of Filters.

It is unfortunately true that such perfection of operation cannot at all times and places be depended upon, and that the water filter, while often doing what seems almost impossible, may not always do all that it has sometimes been called upon to do. In some particulars, such as the removal of turbidity and the removal of color, the eye can readily detect to what extent the water filter had fallen off from giving perfect results. In other particulars such as the removal of bacterial pollution, so as to make the water of satisfactory sanitary quality, it is much less easy to see what has been accomplished by the filter, and because of inadequate supervision and lack of adequate bacteriological testing a filtered water of less than a reasonable standard of purity has often been accepted. This

is particularly likely with a small plant which does not have regular and dependable laboratory supervision. There seems no doubt that a water filter can only affect so much and no more in the way of bacterial purification. Having in mind limits such as these, it will be necessary to consider the raw water to be applied to a filter and to determine how much of a burden the conditions of the raw water will impose on the filter, so as to permit this filter to do reasonably satisfactory work and to apply to a filter only such water as with reasonable preparation can be properly treated to give a good drinking water supply.

Previous Consideration of the Question.

While for some years this question of the proper loading or burden on filters has been considered in many places and attempts have been made to fix some sort of a standard which would serve the purpose, these attempts have met with very little success. The difficulties of fixing such a standard are self-evident. It is rather obvious that no exact relationship exists between the sanitary quality of the water and the number of bacteria present, no matter how the bacteria are tested, whether in the form of total bacteria or some special form such as the colon bacillus. It is possible that some waters should have good sanitary properties and yet have a rather large number of bacteria. Other waters, again, which might be relatively free from bacteria, would show themselves to be unhealthful.

While it has been clearly recognized that some limits, definite if possible, should be placed on the proper burden for filter plants, no such limit has, until recent times, been established.

B. Coli As a Basis of Determination.

The first question that arises for determination is, How Shall the Quality of a Water Be Measured or Determined? For bacterial purposes, bacteria have been taken in various ways, measuring the total number of bacteria either at 20 de-

grees Centigrade or 37 degrees Centigrade on various media. Then, again, special bacteria, such as the B. coli, may be considered a better indication of fecal pollution than total bacteria. In some extreme cases experimenters have suggested the taking of the actual determination of disease bacteria, such as the typhoid bacillus or the cholera bacillus, as a guide to the true disease-carrying source of pollution. Each of these methods has some advantages and some disadvantages.

Considering the last, the direct determination of disease-producing bacteria, this is practically ruled out by the difficulty of making such determinations. It has not yet been generally feasible to determine with precision and certainty whether bacteria such as the typhoid are present in any water, and while such determination is sometimes successful it has not been generally so. In addition, we are not quite sure as to the limitations of water-borne diseases to any specific small number of kinds, and it would be quite possible that even exact and positive exclusion of a certain small number of organisms would not be a guarantee that the water could not contain some other disease-producing bacillus which has not yet definitely been determined as such.

The determination of the total number of bacteria present has been the simplest and most common form of water analysis procedure, and has quite a value. The old standard of the German sanitarians, was an allowance of 100 bacteria per cubic centimeter in filtered water. This standard is a simple and in some ways a useful one, and has been widely extended in this country. Assuming a bacterial efficiency of the filters as 98 per cent., the raw water to give such a filtered water should not exceed a bacterial content of 5,000 per cubic centimeter.

It may be raised as an objection that by far the greater number of bacteria are simply water bacteria or non-pathogenic, and are no indication either of pollution or of having any harmful effect. A water may have a very large number of bacteria and still be absolutely harmless. This objection has

been strong enough largely to discredit the total number of bacteria as being a very good evidence of the wholesomeness or unwholesomeness of any particular water.

The third determination, that of B. coli, has come to be recognized to be the most satisfactory, all things considered, of the possible methods of determining the pollution of a water. B. coli of itself is not, of course, any direct indicator of disease-bearing bacillus. It is only a very indirect evidence of the possibility of recent fecal pollution. As is well known, B. coli originates from many other sources than human fecal excrement. It is found in large quantities in animals, particularly domestic animals. It is also found in considerable quantities on grain materials and tilled fields. Water running off from farm pastures, etc., must necessarily contain considerable quantities of such coli, and under such circumstances B. coli in no way show the evidence of dangerous pollution. Nevertheless, taking everything into account and knowing the limitations of the B. coli as an indicator of fecal pollution, it still must be said that this is the single best means we have of determining whether a water is most probably wholesome or unwholesome according to the number of B. coli present in the water. We recognize that this basis of determination is not at all conclusive or positive, but we also recognize that it is the best we have, and as such it is proper to make use of it in gaging the sanitary qualities of the water.

INTERNATIONAL JOINT COMMISSION INVESTIGATION.

An International Joint Commission, composed in part of appointees of the United States and in part of appointees of Canada, has been investigating the question of pollution of the international boundary waters, with the idea of determining to what extent pollution must be limited in order not to endanger the health of the communities on the two sides of these boundary waters. As a great part, if not all, of the possible danger to health which must arise from drinking water, the question practically resolves itself down to this:

1. Is it possible to maintain the water in such shape that without treatment it shall be suitable for drinking water?

2. If it is not possible to maintain the water in such a condition of purity and it does need filtration before being suitable for drinking water, what is the limit of pollution allowable before the filtration plant will be overloaded, and safe drinking water cannot reasonably be obtained by ordinary filtration.

The first source of information is those cities which have been receiving a supply of unfiltered water which have sufficient data available to show how this water stands in rank on the basis of B. coli present in the water. An examination of these B. coli records and the records of the city, its typhoid data, to show whether this water can reasonably be classed as a fairly healthful and wholesome water or whether it should be classed as a water of rather deficient quality. A second source of information is the various filtered waters which are supplied to a number of communities and the records they have of coli content in this filtered water and the B. coli content in the raw water supplied to those filters. The most of our communities which do have filtered water show a satisfactory effluent and a satisfactory typhoid fever rate, which is some measure of the wholesomeness of the water supplied. An examination of the corresponding raw waters applied to the filters gives some indication of where a reasonable standard limit should be placed. A third source of information is the consideration of a standard of efficiency of bacterial removal and the assumption of a reasonable number of B. coli in water supplied for drinking purposes and a corresponding calculation of what would be a proper natural limit of B. coli in the water supplied to the filters under these conditions.

On the basis of the information of these three classes must be fixed the required standard. This information, which is afforded, is by no means exact in character, and no exact reading can be made from it even in any particular case. Moreover, the various data obtained from various cities are very

conflicting, and even the data obtained at various times from the same cities under apparently similar conditions are conflicting and cannot always be reconciled. Some cities are receiving a markedly poor water in B. coli content, yet have a very satisfactory water from a sanitary standpoint, and typhoid fever rates are relatively low. Others, again, receive a rather good water and deliver for drinking purposes a decidedly good water and yet show a much less satisfactory typhoid fever rate.

It is recognized that typhoid fever originates only in part in water supplies, and that B. coli in the water and typhoid fever rates need not be in any relation to each other.

A case in point is that of the Birmingham, Ala., water supply. This city receives its water from two sources, namely, the Five-Mile Creek and the Cahaba River. The water from the Five-Mile Creek is sterilized after being filtered and shows practically no B. coli as delivered to the consumer. The water from the Cahaba River is filtered but not sterilized, and shows an appreciable amount of B. coli, though not an extraordinary number. Yet the typhoid fever of the two districts supplied from the two plants is no better in the first case than in the second. In the entire city the typhoid death rate is very low during the winter months but is high during the warmer season of the year, when fly transmission becomes a factor of importance.

The best that can be done with the data at hand is to consider all these data, properly weigh them, and on the basis of a rather general judgment come to some conclusion on what is a proper limit of B. coli in water to be applied to the filters. Such a conclusion can by no means be considered an exact judgment, and should be considered rather an average than a rigid limit for any particular case. This standard specifies that water applied to filters should show by the presumptive test not more than 500 B. coli per 100 cubic centimeters of water as a yearly average, meaning by this that B. coli should not be found more than 50 per cent. of the time in 0.10 cubic centi-

meter samples. For averages for shorter selected times, monthly, weekly, or daily, the allowable B. coli content may be considerably higher. It is believed that for this purpose the averages based on a year's readings are more useful than averages for a shorter time with a correspondingly different standard of allowable B. coli.

The adoption of a standard such as this means that, apart from pollution objectionable in other ways than bacterial, the allowable limit of bacterial pollution should be particularly measured by the condition of the water as it reaches the intake of some water supply where the water is purified. If this water shows no more than 50 per cent. positive tests for B. coli in 0.10 cubic centimeter samples as a yearly average, the amount of bacterial pollution arising from a sewer outlet may be considered not too high. If, on the other hand, the bacterial standard so set is exceeded in the water supply, the need is set for the polluting community to purify its sewage by sterilization or further to such an extent that the water will not be affected to a more objectionable degree than the one allowed.

For any particular case to be considered special consideration must be given to the local conditions. If the water is such that practically all the B. coli can be attributed to sewage pollution, a rigid interpretation of the standard would properly be in order. In the case of a stream passing through farming communities where a large part of the B. coli does not originate directly from fecal excrement, but from fields, under such conditions that disease pollution would not follow, this standard can be more liberally applied. Other factors to be considered are the distance of the water supply intake from the source of pollution, the degree of dilution of the sewage effluent, the nature of wind and water currents, which may objectionably or favorably affect the movement of water to a water supply intake, and many other factors of this nature. While it is undoubted that a good deal of judgment must be used in special cases in applying any special standard of purity, and while such a standard cannot be used in ignorant hands as a

substitute for expert supervision and expert judgment, a basis such as this is well worth establishing as a starting point for further investigations.

The bacterial efficiency of a filter is not an invariable quantity. Roughly speaking, 98 to 99 per cent. may be placed as a fair average under ordinary conditions. Percentages, however, are not always a good gage of efficiency, as a water with an initial bacterial content that is high will show a proportionately higher efficiency in a filter than a water with a low bacterial content, and yet the resultant filtered water may be much less satisfactory to the consumer from a healthful standpoint than would be the case with the other filter with a lower bacterial efficiency. In addition, sterilization is usually applied in modern filter plants as a reserve factor of safety, and should be available to be applied in all plants and with the use of effective sterilization added to properly filtered water an effluent can be obtained which is almost, if not entirely, sterile for ordinary use.

With these conditions in mind, it seems reasonably safe to say that a water having in its raw form a coli content not exceeding 500 per each 100 cubic centimeters, based on yearly averages, will show in the water supplied to the consumers something not more than five to ten B. coli per 100 cubic centimeters. Such water is believed to be a fairly safe water, when properly sterilized, for drinking purposes and for all other domestic uses.

LIMITATIONS OF WATER FILTERS.

By Charles A. Finley, *Pittsburgh, Pa.*
(Discussion of paper by George W. Fuller.)

The treatment of water supplies, in order to secure water of proper sanitary quality, in connection with the treatment of sewage affecting these supplies, is one of the great questions of the day in its bearing on public finances. These two subjects are closely related, and, due to the large financial outlay necessary to obtain required results, their correlative value and efficacy should be closely studied.

Most American cities have available within their reach a source of water supply still capable of purification by the ordinary modern methods of filtration and sterilization. The growing demand for public improvements in recent years has amply demonstrated that the public treasury is not inexhaustible, many large cities having already closely approached their legitimate bonding power.

As would logically follow, centers of population have and do resort to the cheapest and quickest method of obtaining the required sanitary results, namely, the purification of the amount of water that they need for their own use, rather than the more expensive and possibly illogical method of treating all sewage on the water-shed in the hope that the supply may be maintained of sufficient purity to avoid special treatment. This is a logical, economic development, and although selfish in its basic elements will probably prevail as long as it produces the required results and until the present methods of water purification fail. When the sanitary and aesthetic limitations of water purification have been reached, and it becomes necessary to eliminate by this or some other treatment the sources of pollution from the water, the public policy of handling the question must change accordingly.

The prevention of the pollution of large water supplies, which still retain great reserve capacity for dilution, does not seem to warrant either the close study or immediate financial outlay that the treatment by modern methods of the water supplies drawn therefrom, warrants.

Commendable as is the prevention of water pollution, nevertheless immediate results are demanded. The difficulties, financial and otherwise, of cleaning up all water-sheds on short notice, or even of permanently maintaining this condition on long notice, are apparent, but the possibility of purifying all water supplies is a much more tangible proposition. Therefore the method before mentioned promises the greatest sanitary efficiency, in the absence of sufficient funds to accomplish both results. It is not to be presumed that sewage purification should be abandoned, but rather that it should be a subsequent development, taking place when conditions would indicate that purification of the water supply was becoming a difficult problem, with reasonable possibility of failure.

As an eminent American engineer once said: "It is better to pay one dollar for water purification than ten dollars for sewage purification, when commensurate values are considered."

In the purification of water supplies, the question of pollution, studied in connection with modern laboratory reports thereon, might be classified under three heads:

Total Bacterial Pollution—Considered on the basis of total bacterial content present, regardless of their identity;

Sanitary Pollution—May be outlined as the presence of bacteria or other organic matter foreign to water, without specific reference to the presence of pathogenic organisms and generally arrived at by the determination of B. coli or some other specific organism;

Pathogenic Pollution—The presence of disease-producing organisms, the removal and destruction of which is the real function of water purification.

The method of isolation and identification of pathogenic organisms by modern laboratory methods are entirely inadequate to meet the practical requirements of the case. The total bacterial count is of little or no diagnostic value, and it has become customary to determine what is therein designated as sanitary pollution by a general identification of some associate bacteria which must arrive at their destination by the same routes as would be followed by the pathogenic or indicative disease-producing organisms. The presence of the colon group is assumed to indicate that the route of contamination is open. Modern practice tends more to the prevention of sanitary pollution than to the consideration of the total bacterial content of a given water. Studies apparently indicate that there is no necessary relation between total bacterial content and the B. coli content. However, a high degree of efficiency in decrease of bacterial content by a filter generally means a corresponding high reduction in coli content.

The establishment of arbitrary limitations to the satisfactory efficiency of water purification, measured and defined according to the coli content of the raw water, must always be considered and applied with reference to the special circumstances attendant on each case, especially if the attainment of that limiting coli content in the raw water implies as a resultant conclusion therefrom that sewage treatment on the water-shed has then become necessary, in conjunction with filtration, in order to secure a proper water.

There are large cities where the coli content of the raw water greatly exceeds 500 per 100 cubic centimeters; nevertheless this water is successfully and satisfactorily treated by modern methods of filtration and sterilization. In fact, there are large sections of this country where raw water, coming within the limitations above defined, is not available, but which water nevertheless responds readily to modern treatment.

REPORT OF COMMITTEE ON STREET LIGHTING.

J. E. PUTNAM, *Chairman, Rochester, N. Y.*

This very brief report is intended to show the tendency to change in the matter of street lighting methods, and does not attempt to give complete statistics of the subject.

During the year since the Wilmington convention a joint committee of the National Electric Light Association, and the Association of Edison Illuminating Companies, has been formed and a progress report of the committee has been made. This report describes tests made on streets lighted in various ways for the purpose of experiment.

The tests included the usual photometric tests, and in addition a number of novel visibility tests indicating the value of various lighting installations for revealing:

First—Surface irregularities, and

Second—Large objects on the street.

As the work of this committee is not complete we cannot fairly come to any conclusion from the partial results reported.

We may note in passing, however, that the cardinal purpose of the experiments so far has been to determine the minimum lighting and its arrangement, which will make the streets safe to use.

Most of our cities demand much more light than this. We may also note that there is a well defined tendency to call attention to the value of contrast as compared with diffusion.

During the year there has been made available a new type of tungsten lamp for street lighting—the non-vacuum or nitrogen filled lamp.

This lamp is made in many sizes, and is made to burn either pendent or upright. The sizes most used so far seems to be 300 and 500 watt.

There has been a large increase in the number of magnetite lamps, both pendent and inverted.

Some cities, as for instance Denver, have installed increased numbers of metalic flame arc lamps, while many smaller cities have increased the number of ornamental cluster posts.

STREET LIGHTING PRACTICE WITH INCANDESCENT LAMPS.

By G. H. Stickney, *in Charge of Illuminating Engineering for Edison Lamp Works, Harrison, N. J.*

In the lighting of a modern American city, one encounters a range of practice varying, step by step, from the dim lighting in the outlying districts to the brilliant lighting of the main central thoroughfares. This typifies, in a way, the historical progress of the art from the time the best street lighting consisted merely of beacons to guide the travelers, up to the present standard of ornamental street lighting. Nor has the practice shown an indication of having reached an ultimate standard. On the contrary, the rate of advance at the present time seems to be more rapid than ever before. Never has the value of good street illumination been so highly appreciated. While the recent improvements in illuminants, tending toward the economical production and utilization of light, seem likely to result in raising the standard rather than in reducing the cost to any great extent.

The history of street lighting indicates that better lighting follows closely on the availability of improved illuminants. As an example of this, we may note the advances which followed when the open arc became available about 1878; the enclosed arc about 1895; the luminous arc about 1904; and the tungsten filament incandescent lamp about 1907.

Purpose.

While the purpose of street lighting has been discussed frequently, it is desirable that we have clearly in mind the purpose of the illumination.

For ordinary or utility street lighting, the main purpose is to permit the traveler to pursue his way with safety and con-

Fig. 1. Bracket fixture for low power Mazda series lamps, with prismatic globe and metal reflector. See Fig. 2 for distribution of light.

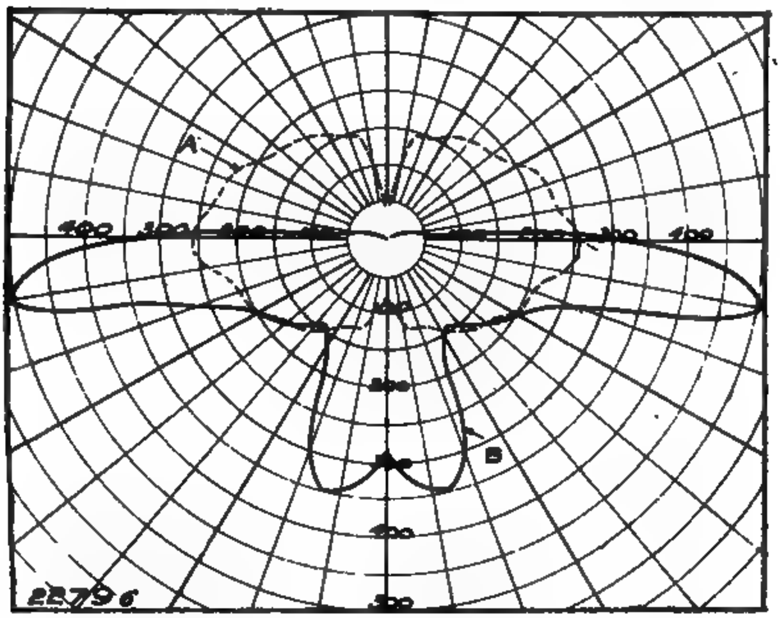


Fig. 2. Photometric curve showing light distribution of 250 c. p. series Mazda lamp with (curve B) and without (curve A) reflector and reflector equipment of Fig. 1. Candle power at angles just below horizontal practically doubled, making these lamps good for wide spacing.

venience. In outlying roads, the lighting may serve merely as a guide to enable the traveler to keep on the road. In city lighting it is important that one be enabled to avoid irregularities in the street, as well as collision with others. Where the density of traffic is greater, the danger of collision is correspondingly increased, and hence clear and quick vision is more necessary.

Nowadays, thanks to the extension of street lighting, we hear less about the value of street lighting as a protection against persons of evil intent—robbers, highwaymen, etc. Yet we must not overlook the importance of street lighting in the preservation of the peace. The extension of good lighting into sections of a city which are subject to disorder, is one of the most effective means of eliminating the evil.

Beyond all this, however, there is another purpose for street lighting, which has developed rapidly in the past decade, and has demanded for certain sections of a city an intensity of illumination which often considerably exceeds that required for safety. The new element of such lighting is the endeavor often made, at considerable expenditure, to render the street more pleasing and attractive. This is the motive of the so-called ornamental or whiteway lighting.

Owing to the influence of the ornamental lighting, this purpose is also now felt to a greater or less degree in ordinary street lighting.

Illumination Effects.

The practice as regards illumination effects may be considered from several distinct standpoints. It is useful to classify the practice, however, with regard to the extent and nature of the illumination, as follows:

(1) Beacon lighting.
(2) Uneven illumination.
(3) Even illumination.

Beacon Lighting.

This character of lighting has already been mentioned. Practically no illumination falls on the roadway, the low in-

Fig. 3. Typical equipment for high power Mazda lamps, with diffusing globe and with (or without) metal reflector; with compensator for stepping up current at lamp, or without for series lamps See Fig. 4 for distribution of light.

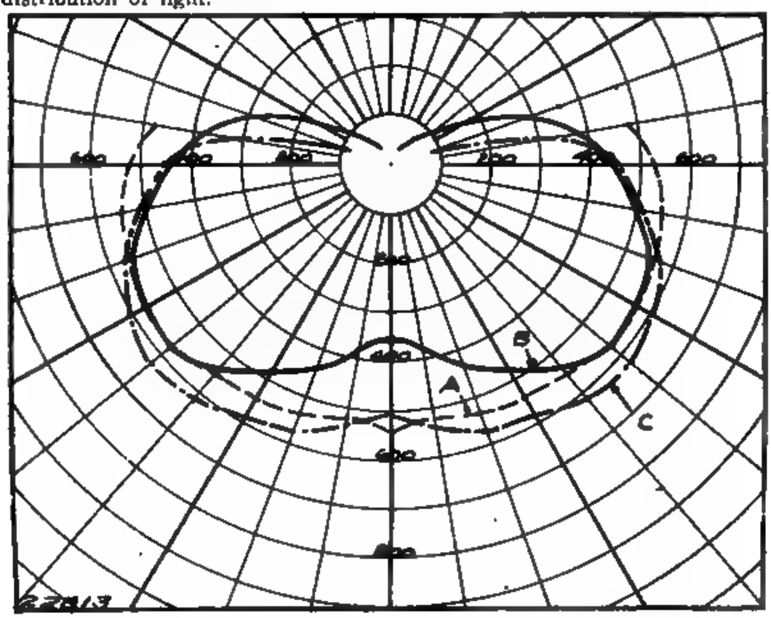


Fig. 4 Photometric curve of 600-c p. 20-amp compensator type series Mazda lamp with clear globe and shallow metal reflector (curve A); diffusing globe and no reflector (curve B); diffusing globe and shallow metal reflector as in Fig. 3 (Curve C). Diffusing equipment suitable for narrow lamp spacing.

UNEVEN ILLUMINATION.

tensity lights serving by their location, to indicate the course of the road, much as lighthouses and beacons at sea guide the navigators. Such lighting is, of course, inadequate for city streets, but for rural roads, where questions of cost may prohibit the adoption of a higher standard, such lighting will add considerably to the safety of travel; and for such conditions the extension of even this low intensity lighting will be beneficial in developing the country.

This refers to the practice often observed where areas of street, near the lamps, are illuminated to a fair intensity, while the intervening sections are but slightly illuminated, and may, in contrast to the illuminated portions, appear to be in absolute darkness. The practice originated through the early use of arc lamps, especially the open carbon arcs, which, for economy, were spaced at wide intervals—usually at street intersections. At first thought this practice may seem to be entirely unjustified, except on account of the peculiarities of the illuminants, which, in the case mentioned, were inherently of relatively high power.

However, there has been much discussion and difference of opinion on this subject on the part of students of street lighting practice. For certain conditions there seems to be more reason for the practice than would appear on superficial consideration.

Where the intensity of street illumination is very low, large objects, vehicles, etc., are seen in silhouette—usually as dark outlines against an illuminated street surface. Under such conditions experience has shown that such objects can be seen at a much greater distance by the uneven illumination, than if the same total amount of light were evenly distributed.

Since high power units, widely spaced, cost less per mile of street than low power units at correspondingly narrower intervals, it often happens, where the cost of street lighting must be minimized, that this is the most practicable method of lighting. By locating the light sources over the street at points of

Fig. 5. Reflector equipment for high-power Mazda lamps, usually furnished with compensators to take high current lamp. Globe and reflector equipments are interchangeable. See Fig. 6 for distribution of light.

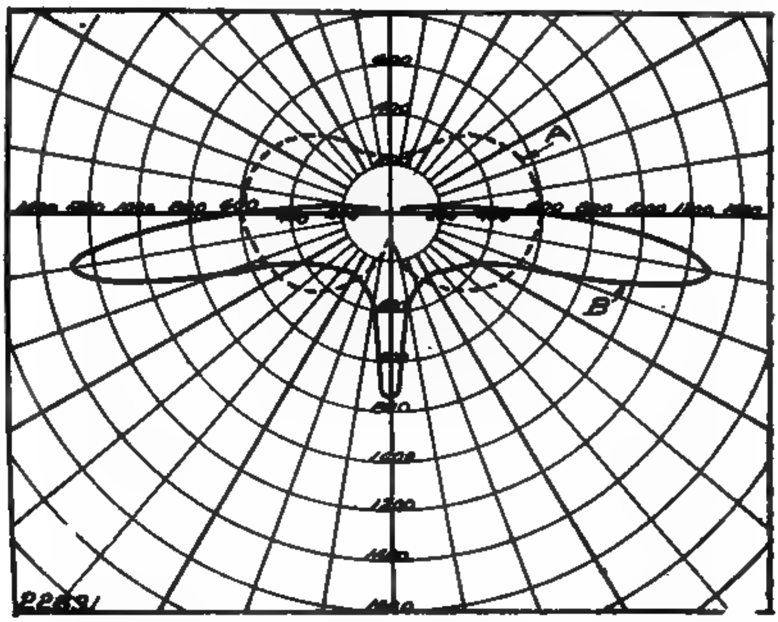


Fig. 6. Photometric curve of 600-c.p. lamp unequipped (curve A); equipped with prismatic reflector and metal reflector as in Fig. 5 (curve B). High candle-power shown in curve B shows lamps are advantageous for wide spacing.

street intersections, where the greatest danger of collisions exists, this method is likely to meet the needs of the drivers of vehicles, especially swift-moving automobiles, although the glare may be objectionable.

The weakest point of this method is that it does not serve the pedestrian on the sidewalk advantageously. Especially where there is dense foliage, or streets are curved and narrow, it is not effective. Where there are irregular intersections of streets, some crossings cannot be properly illuminated without a narrower spacing of lights which may offset the principal advantage, namely, low cost.

Even Lighting.

We commonly refer to a street as evenly lighted if the intensities on the surface do not vary more than say 10 or 15 to 1. With such lighting the street appears to the ordinary observer to have an even illumination.

The appearance of the street is very greatly improved with such lighting in contrast to the spotted illumination discussed previously. With higher intensity illumination, it is possible to see better than with corresponding uneven illumination; moreover, the cost is not likely to be much greater.

Classes of Streets.

While street lighting, as already mentioned, is graded by steps from the business center toward the suburbs, it is evident that it is not practicable to have too many steps, lest the lighting system become too complicated for economical operation. The variation usually should not be uniform in all directions, but should depend upon the character and importance of the streets, amount of traffic, etc.

This problem can best be studied by classifying the streets or sections of streets in a small number of groups having similar requirements; and reviewing their needs. Such classification would, of course, vary for different types of cities; for example, it is apparent that street lighting in Manhattan Boro would not typically represent an average American city; and

Fig. 7. Ornamental pole top equipment for high-power series Mazda lamps. Three slightly different designs of poles are shown, of various degrees of attractiveness by day and by night. See Fig. 8 for the surprisingly good distribution of light.

that manufacturing cities would not exactly correspond to residential cities. However, our purposes can be sufficiently served by the following general classification:

(1) Principal business streets.
(2) Ordinary business streets and thoroughfares.
(3) Residential streets and parkways.
(4) Outlying streets, newly developed sections.
(5) Rural street and interurban highways.

Whiteway lighting of the principal business streets demands not only the highest intensity of illumination, but diffusion and evenness. The tendency is to provide the maximum illumination opposite the buildings rather than at the street intersections. This is especially true when the lighting is promoted by merchants for advertising purposes. It is, however, good practice, since the illumination on the building fronts plays an important part in rendering the street attractive; while the illumination at the corners is almost certain to be sufficient for all purposes. Further, since most of this class of lighting employs ornamental lamp posts along the curb, it is often desirable to avoid placing lights at the street corner, as the glare from such a lamp in the eyes of a vehicle driver, who is about to turn a corner and wishes to see beyond, is likely to be more objectionable than the increased light is advantageous.

That the illumination of the building fronts contributes considerably to the cheerful appearance of the street, is evident from the gloomy appearance when the light is cut off from the buildings, even though the surface of the street is well lighted.

Ordinary business streets, thoroughfares and residential streets, in which houses are in blocks and foliage absent, should differ in treatment from the principal streets only in the degree of intensity and ornamental effect. The lighting units should be so arranged as to provide ample intensity at street intersections.

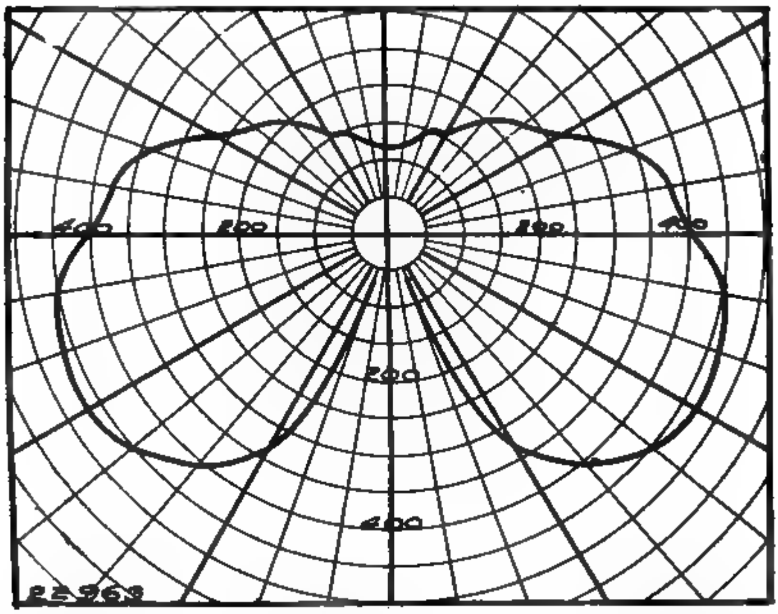


Fig. 8. Photometric curve of 600-c.p. series Mazda lamp, equipped as a pole top unit with diffusing globe as in Fig. 7. The globe shape, determined by much experiment, has much to do with the effective distribution.

Fig. 9. Ornamental pole top equipment for high power series Mazda lamps. Light distribution not so effecient as with lamps in Fig. 7.

In the usual residence streets and parkways, where foliage abounds and the border of building fronts is absent, upward light is of little value. The degree of illumination required depends upon the amount of travel. The decorative value of the fixtures should, as far as practicable, correspond to the character of the street. As a rule, lights must be placed low to avoid tree shadows. Hence, a fairly frequent spacing with low power lamps is required. Where foliage be absent, wider spacing and larger units are practicable and often more economical.

For outlying and newly developed sections, which are likely to develop as residence sections, it is well to provide a spacing corresponding to the residential sections, securing economy by the use of low power lamps and arranging for effective distribution, even if some glare is present. This will permit changing readily as the demand for better illumination develops.

As we have already noted, the physical character of the street has a very decided bearing in determining the design of the lighting system. The width of the street should have a considerable influence in determining the height, spacing and arrangement of lighting units.

A factor which is often overlooked is the color of the street surface. A dark street surface demands much more light for effective seeing than a light one. The oiling of streets, which were formerly a light colored macadam, has been a frequent source of complaint of the street lighting, though the cause of the deficiency has often been overlooked. It can hardly be expected that streets will always be finished to suit the street lighting, but since the color has so decided an effect on the illumination, the lighting should be considered in this connection.

The variety of factors entering into the problems of street lighting render it necessary to make many compromises. The desirability of unity of design throughout a city, should not be overlooked, especially in the lighting of a long thoroughfare, which may extend from a business center to the outskirts. In such a case it may be necessary to sacrifice the peculiar re-

Fig. 10. Ball globe pole top equipment for low-power Mazda lamp used in Rochester, N. Y., with concrete pole.

quirements of a particular section, to the production of an effective whole. It is usually practicable to grade the illumination by using lower power units of similar design, or by using wider spacing, away from the center. In case more than one light source per pole is provided, it is sometimes advisable to secure this result by varying the number of lights per pole.

Arrangements of Lights.

Quite a variety of arrangements of lighting units are in vogue, but the recent installations show a marked tendency toward the use of poles along the curb line, with lamps upright at the top of the pole, or hung pendent at the end of a short arm or ornamental neck. Especially in those cases where attractive appearance is considered important, the pole top unit predominates. See Figures 7, 9 and 10.

In the early installations of large units, it was the common practice to suspend the lamp over the middle of the street. This arrangement undoubtedly is generally the one which provides for the most economical distribution of light and is advantageous for producing silhouette effect. On the other hand, this position, unless the lamps are hung very high, gives maximum glare in the eyes of a driver; while the overhead construction is rather unsightly in the daytime. Long arm suspensions on curb poles are frequently advantageous, especially where foliage is present, but here again glare at night and unsightly appearance in daytime, are likely to be encountered.

When tungsten filament incandescent lamps were available only in small sizes, it became the practice, especially in ornamental lighting, to group four or five, and sometimes more, lamps in individual round globes at the pole top. The effect, particularly of the individual pole, was very attractive. Probably no other type of lighting units ever enjoyed as wide popularity or secured as rapid application. It was well known among engineers that, on account of the loss of light by ineffective distribution as well as the interference of absorbing surfaces, this scheme of lighting was wasteful of light. When larger size tungsten lamps became available, with their higher efficiency and lower maintenance cost, the relative extravagance of the cluster lighting became more apparent. As a rule, the one or two light units, while individually less striking in appearance than the four or five light cluster, make a better perspective appearance of the street, and are more efficient, so that today cluster lighting is gradually giving way to these simpler designs.

Pendent units can be made to present a neat appearance in the street, and have the advantage of usually providing a more economical distribution of light, especially in the residence districts, where the upward light can be cut off by reflectors and utilized. See Figures 12 and 13.

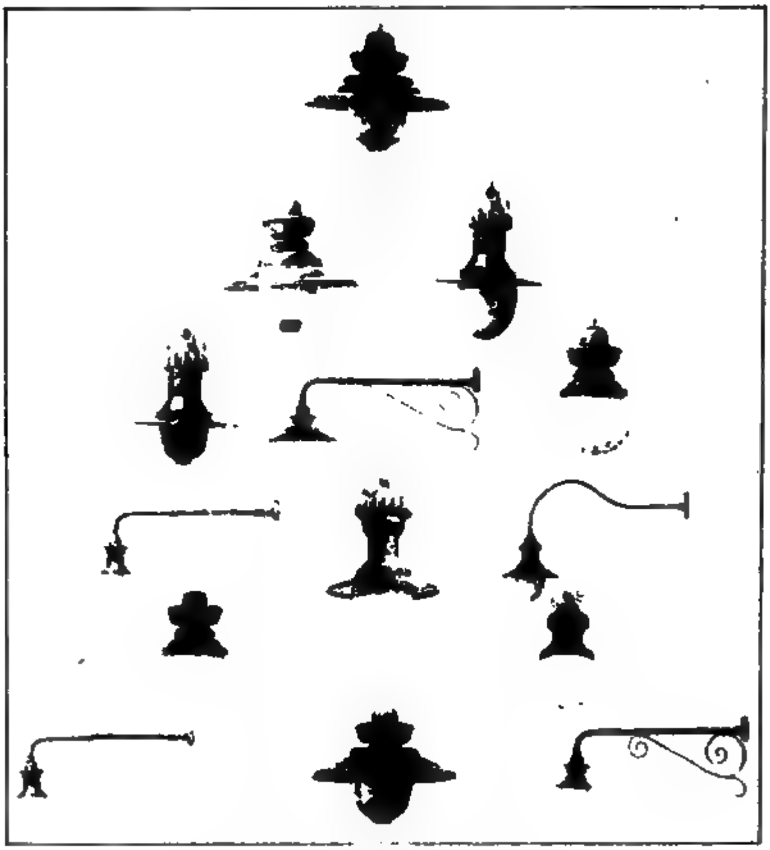


Fig. 11. Group of pendent fixtures for street lighting with Mazda lamps. There are many other designs.

There is considerable difference of opinion as to the relative advantages of placing poles opposite, staggering alternately from one side of the street to the other, and arranging them along one side of the street only. The opposite arrangement makes the best appearance and, on wide streets, gives fairly even lighting with proper spacing.

On narrower streets, especially with wide spacing, the staggered arrangement gives a better distribution of illumination. With very low intensity lighting, particularly on curved road-

Fig. 12. Two-light ornamental pole with pendent fixtures for Mazda lamps, in use in Hartford, Conn., presents an attractive appearance and is especially suitable for the conditions. Note the distribution of the poles down the street within the view.

ways, as in parks, the staggered arrangement should be avoided; it has sometimes led drivers to run off the roadway, and where dangerous obstructions occurred at the roadside, this has resulted in serious accidents.

The arrangement of poles on one side of a narrow street is often very effective and economical, and is especially applicable to the lighting of parkways, and suburban or residence streets. This arrangement is not likely, however, to meet with favor in commercial streets, as it tends to draw pedestrians to one side of the street, to the disadvantage of stores on the other side.

On boulevards and wide streets, having grass plots in the center, it is often advantageous to locate lamp poles down the center, or in some cases, to combine this arrangement in various ways, with lines along the curbs.

In some cities small incandescent lamps have been arranged in arches or festoons, either across the street or along the curb. Very few permanent installations on this order have been made. The lighting may be quite evenly distributed over the street surface. The general effect, however, is more of a gala or festive one, more suitable for a celebration or other temporary occasion, rather than for permanent lighting.

Height and Spacing of Lamps.

It is impracticable to give an accurate rule for determining height and spacing, but the following comments based on the practice should be helpful.

The spacing of lamps differs for various arrangements of poles, as well as for the power of unit and intensity of the illumination required. The height and spacing are interdependent and each should be determined with relation to the other, allowance being made for the characteristic distribution of light from lamp employed.

Too frequent spacing of lamps should be avoided to prevent cluttering the street with poles. This, however, is an unusual fault, since economy usually tends to dictate too wide

a spacing for the most effective lighting. In business districts, the spacing between pairs of opposite poles, or along the street between staggered poles, generally runs between 60 and 120 feet. In residence districts the spacing is a little wider, say, 100 to 200 feet. In older installations, spacing as wide as 400 feet is not uncommon; but with the range of sizes of lighting units available, it is seldom good practice to space lamps further than indicated above, except for the so-called beacon lighting. The tendency is toward narrower spacing, using smaller power lamps, if necessary, to secure economy.

Except, as mentioned elsewhere, with regard to ornamental street lighting, it is advantageous to provide at least one lamp at each street intersection, and the spacing should be planned with this in view. Where blocks along a street vary in length, spacing for different blocks can be slightly modified from the average, to equalize the intervals for each block.

In planning locations, it is sometimes found advantageous to indicate lights by means of small weights on a plan of the section to be lighted, and thus trying the different possible arrangements and spacings until the best one is obtained.

In grading the lighting for a city, comparisons can best be made in flux of light per unit of street length or area. A few years ago when lamp efficiencies were more uniform, such comparisons were often made in watts per running foot of street, but at the present time mean spherical candlepower per foot, or lumens per foot, will be more reliable. A more accurate measure, especially for high intensity lighting, would be in terms of the average foot candles of intensity on the street surface. This involves a more laborious calculation, based on particular arrangement of units and reference to photometric curves, and is not ordinarily justified.

In the very complete tests being run under the auspices of the National Electric Light Association, and the Association of Edison Illuminating Companies (Report of Street Lighting Committee, N. E. L. A. 1914), both the intensity of the illumination falling on the street and the brightness of the surface

Fig. 13. Single-light ornamental pole and pendent fixtures in use in Hartford, Conn., on the narrower business streets and to extend the lighting on principal wide streets away from the business center. Note the arc light on arm over street and the low ornamental light clusters in the background, showing that no complete design has yet been installed.

have been measured; and it is to be hoped that the data accumulated will furnish a more complete guide for the interpretation of street illumination valves.

It is evident that lamps hung over the street need be higher than if located along the side. The general tendency is to

place lamps too low. High power lamps and those having high intrinsic brilliancy need to be placed higher than low power lamps, or lamps with light diffusing equipment. Also, lamps which emit a larger proportion of light downward should be hung higher than those which distribute the light at wide angles.

For high power lamps, hung in the center of the street, the height in practice runs from 20 to 35 feet, or even higher. It is seldom advantageous to hang such lamps less than 25 feet above the ground.

High power pendent lamps, along the curb, are usually from 18 to 25 feet from the ground, but pole top lamps with diffusing globes are often placed as low as 14½ feet. Small units along the curb run from 10 to 16 feet high.

Intensity.

Intensity is the measure of the brightness of a light source or of the illumination falling on a surface.

The intensity of a light source is measured in candlepower. The candlepower of most units varies for different directions, although for nearly all types the distribution is symmetrical with regard to the points of the compass. Some sources do not give a steady light, so that the candlepower varies from instant to instant.

The candlepower of a lamp is subject to depreciation with time, due to various causes, such as shrinkage of the light source, depreciation of luminous material, accumulation of deposits on the surrounding glass (products of combustion, or evaporation peculiar to the illuminant) or to dust and dirt.

Thus we see that candlepower is a very indefinite term and, unless we specify other conditions, does not represent an accurate value. In the case of incandescent electric lamps or gas mantles, it has become the practice to rate in terms of mean horizontal candlepower, i. e, average candlepower given in a horizontal direction, with new lamps and test conditions. Hence this value is understood when nothing else is specified.

Otherwise, it is necessary to qualify the candlepower, defining it with one or more of the following qualifications: initial candlepower, average candlepower throughout life of trim, maximum candlepower, candlepower at a specified angle of elevation, mean spherical candlepower, mean (lower) hemispherical candlepower, mean horizontal candlepower, mean candlepower from 0 to 60 degrees, etc.

When we have the mean spherical candlepower, or mean candlepower, in any zone, we may determine the flux of light in lumens, by multplying by the solid angle corresponding.

For example: The total lumens emitted by a lght source is equal to the mean spherical candlepower times 12.57 (4 Pi).

The lumen, being a newer unit and less familiar to the layman than candlepower, is sometimes looked upon with suspicion and disfavor. In reality it is more definite than candlepower, unless the latter is elaborately explained. Since the unqualified lumen is the highest value obtainable, it is less liable to be used to deceive, either through ignorance or intent.

Intensity of illumination falling on the street is measured in foot candles (in scientific circles sometimes meter candles). This may refer to the intensity on the horizontal surface of the street, on a plane normal to the light rays, or a vertical plane. Measurements of either horizontal or normal foot candles, for particular points in the street, are made by means of portable or illumination photometers. Recently measures of average brightness of street surface have also been made.

With regard to the horizontal and normal intensities, there is some difference of opinion among lighting experts as to which is the most correct measure of the value of the illumination. The horizontal foot candles measure the illumination falling on the flat surface; the normal foot candles, the brighest illumination on an ordinary obstruction. For high intensity it is common practice to use the horizontal value, while for low intensity lighting, especially with wide spacing, the tendency is toward the use of the normal.

Under the latter condition it is often very difficult to make horizontal measurements; moreover it is generally conceded that the normal values give a fairer measure of the usefulness. The two values cannot, usually, be compared directly. Both values can be calculated from candlepower curves, for points at a known distance from the illuminants. The calculated horizontal illumination from two or more sources may be added to give the total intensity, but normal illumination represents only the illumination from one lamp.

Since each calculation determines the intensity at one point only, it will be seen that considerable calculation would be necessary to determine the illumination throughout a representative section of street. It is common to give the values at representative points, as along the center line, half way between lamps, directly beneath lamps, or to plot curves showing rate of variation or lines of equal intensity.

By dividing a section of street into squares and assuming that the horizontal intensity in the center of each square represents the mean intensity of the square, it is possible to determine the average intensity on the street surface.

It is possible to figure from the above the flux of light over a section of street (foot candles x sq. ft. = lumens), but it is more common to figure the illumination in terms of intensity.

Lighting Units.

Practically all street lighting within the reach of distributing mains utilizes electric or gas lamps. Up to about 1876 to 1880, the open gas flame was the only unit of this kind available. Since that time the arc lamp in its various forms (open carbon arc, enclosed carbon arc, luminous or magnetite arc, and flaming arc) has been largely used. Of these the luminous arc is today by far the most important. The arc lamp is essentially a high power unit.

About 1896, the gas mantle lamp came into use. The first lamps were provided with the upright mantle. More recently inverted mantles have been applied, but as the upright mantle

distributes the light more effectively for most conditions of street lighting, its use has predominated. This is what is commonly known as a low power unit, though higher power units have been made by grouping. In recent years, high pressure gas mantles, as high power units, have been used to some extent in Europe, although they have not been applied in this country except in a very few cases.

The incandescent lamp came into other use in the early eighties, and a little later was applied to a small extent for street lighting as a low power unit. It did not become an important factor in street lighting until the development of the tungsten filament, about 1907. From that time until early in the present year, the incandescent lamp was used principally as a low power unit, in sizes of 100 c.p. and less.

Remarkable developments, resulting from scientific research (Research Laboratory, G. E. Co., Schenectady, N. Y.) have recently extended the range so that series incandescent lamps are now available in steps up to 1000 c.p., and multiple lamps somewhat higher. There seems to be nothing to limit the size of such lamps available in the future, except the demand.

The recent improvement, which consists partly in the use of an inert atmosphere within the bulb, has not only been responsible for extending the capacity, but has produced high power Mazda lamps of double the efficiency of previous tungsten lamps, and 6 to 8 times the efficiency of the carbon incandescent lamps. Corresponding gains of smaller magnitude have been made in the lower power Mazda lamp. In the appendix will be found a list of the capacities of these new lamps now available, with efficiency and power data. While these lamps have become available within the past year, it is interesting to note that over half a million have already been made for use in the United States.

These lamps partake of the general characteristics of the ordinary (Mazda) tungsten incandescent lamps which are too well known to require extended discussion. The lamps give a steady light, free from flicker. The color of the light ap-

proaches more nearly to that of daylight than does that of any other form of incandescent lamp, but still is of slight yellowish or warm tint. While slightly more subject to variation in candlepower between individual lamps, than were the vacuum (Mazda) lamps, they range more closely than any other lamps. All lamps of any type are subject to candlepower depreciation with time of burning, but with these new lamps the depreciation is less than with any other, seldom reaching as high a value as 20 per cent. of the initial candlepower.

One feature in which these new lamps differ from the other types of Mazda, is that there is a greater variation in efficiency between large and small multiple lamps, as well as between multiple and series lamps. This is due to the fact that the gas within the bulb introduces a convection loss which is relatively greater in lamps consuming a low current (amperage). (In the smaller sizes of series lamps the conduction loss on high current lamps may reverse this.) Thus, for 110 volt multiple circuits, the high wattage lamps are more efficient than the low wattage. In the case of the higher power series lamps, the higher current lamps are more efficient than the lower current. To take advantage of this fact some of the higher power lamps are made for 20 (or 15) amperes. Fixtures or housings for such lamps have compensators, so that the lamps can be used on ordinary alternating current series circuits, as, for example, 6.6 or 7.5 amperes.

In these new lamps the candlepower per square inch of projected light source is higher than in the former type. On account of the greater brilliancy, which approaches more nearly that of the arc, it is more essential that in the fixture equipment greater attention be given to diffusion, in order to avoid objectionable glare, especially in the larger units. This same feature is advantageous in permitting more accurate control of the light by means of reflecting and refracting devices and has been taken care of as mentioned in connection with the subject of fixtures.

Fixtures for Incandescent Lamps.

Experience in the design and use of incandescent lamps has shown the advisability of making the lamp proper as simple and universal in its application as possible. Various conditions of street lighting make a demand for different characteristics

(All Lamps ¼ Scale.)

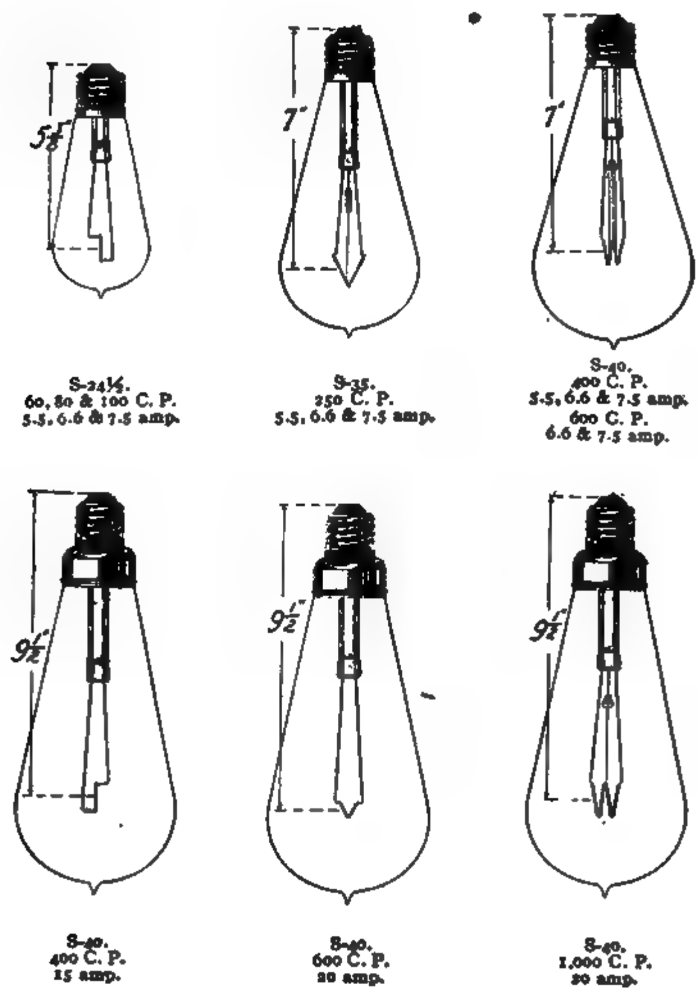
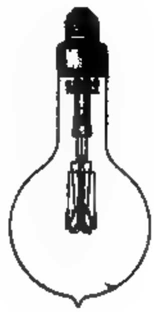
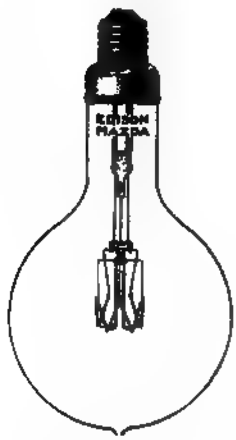


Fig. 14. Typical series Mazda lamps as now made by the leading manufacturers. For data see tables 1, 2, 3, 4 following the paper.

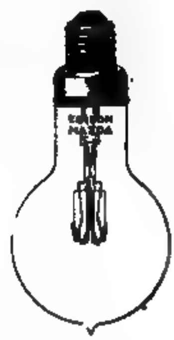
200-w. lamp, G-30 bulb
Diam., 3¾ in.
Length, 8⅜ in.



300-w. lamp, G-35 bulb
Diam., 4⅜ in.
Length, 9¼ in.



750-w. and 1000-w lamps,
G-56 bulb.
Diam., 7 in.
Length, 13½ in.



400-w. and 500-w. lamps,
G-40 bulb
Diam., 5 in.
Length, 11 in.

Fig. 15. Some new type Mazda lamps for 110-v. (nominal) multiple circuits; sometimes used for street lighting but not so often as the series lamps of Fig. 14. See table 3 for data.

of light distribution, different degrees of diffusion, different artistic appearances of equipment, etc. These factors can most effectively and economically be provided for by variations in fixture design. This has been generally recognized and there are now available many styles and makes of fixtures and housings to adapt incandescent lamps for these numerous requirements.

So numerous and adaptable are the styles of equipment now to be had that there seems to be little or no need for the production of special designs, except where, as a matter of individuality, it is deemed desirable to provide something which differs from that in use elsewhere. In such cases it is important to make sure that such special equipment meets the local needs at least as well as the corresponding standard fixtures. It sometimes happens that such fixtures while beautiful to look upon, are unnecessarily extravagant and waste light, or distribute it ineffectually. In higher power units it is necessary to make sure that the enclosing equipment provides proper ventilation for the lamp. The lower power lamps have been designed for fixtures already available for the vacuum type. These, in general, are too well known to require attention in this connection.

A new device, having advantageous characteristics, especially where wide distribution of light is desired, has recently become available. This is a prismatic refracting globe, which consists of two concentric pieces of clear glass with refracting prisms. One set of prisms directs the light so as to produce an intensity of approximately double the rated candlepower of the lamps at an angle of 10 degrees below the horizontal. This gives a powerful light to illuminate those portions of the street intermediate between lamps, where the illumination is usually weakest. The other set of prisms serves to diffuse the light, so that the entire globe appears luminous, thus reducing the intrinsic brilliancy. Bots sets of prisms are sealed in so that only the smooth glass surface is exposed, having the advantage of minimizing the possibilities of dust collection and facilitating cleaning. A typical photometric distribution curve is shown in Figure 6.

For the higher power lamps new lines of fixtures have been developed. The accompanying illustrations show a typical line of such fixtures with the various light distributing equipments. The photometric curves indicate the character of distribution, while the foot notes give general memoranda regarding the application of the units.

APPENDIX.

Data on Non-Vacuum Mazda (Tungsten) Lamps for Street Lighting Service.

TABLE I.

Series Lamps for Operation Directly on 6.6 Ampere Circuits.
Unskirted Mogul Screw Base. (Fig. 14.)
Rated Life—1,350 Hours.

Mean Horiz. C. P.	Watts Per C. P.	Watts	Mean Spher. C. P.	M. S. C. P. Per Watt	Total Lumens	Lumens Per Watt	Maximum Diameter (Inches)	Length Overall (Inches)
600	.64	384	480	1.25	6048	15.7	5	10
400	.64	256	320	1.25	4020	15.7	5	10
250	.65	163	200	1.23	2520	15.6	4 3/8	9 3/4
100	.71	71	76	1.07	955	13.5	3 1/16	7 1/4
80	.74	59	61	1.03	768	13.0	3 1/16	7 1/4
60	.78	47	45	.96	567	12.1	3 1/16	7 1/4
The following candlepower sizes can be obtained but are not standard.								
40	.88	35	30	.86	378	10.8	3 1/16	7 1/4
32	.96	31	24	.77	302	9.7	3 1/16	7 1/4

TABLE II.

Series Lamps for Operation Directly on 7.5 Ampere Circuits.
Unskirted Mogul Screw Base. (Fig. 14).
Rated Life—1,350 Hours.

Mean Horiz. C. P.	Watts Per C. P.	Watts	Mean Spher. C. P.	M. S. C. P. Per Watt	Total Lumens	Lumens Per Watt	Maximum Diameter (Inches)	Length Overall (Inches)
600	.62	372	480	1.29	6048	16.3	5	10
400	.62	248	320	1.29	4020	16.3	5	10
250	.63	158	200	1.27	2520	16.0	4 3/8	9 3/4
100	.71	71	76	1.07	955	13 5	3 1/16	7 1/4
80	.74	59	61	1.03	768	13.0	3 1/16	7 1/4
60	.78	47	45	.96	567	12.1	3 1/16	7 1/4
The following candlepower sizes can be obtained but are not standard.								
40	.90	36	30	.83	378	10.5	3 1/16	7 1/4
32	1.03	33	24	.73	302	9.2	3 1/16	7/1/4

*1. Bitulithic 11% not economical. Good results up to 9%. Wood block 3% in alleys.

*2. Concrete doubtful. We have some sheet asphalt here on 7% grades where the traffic consists of automobiles and light vehicles. Should the traffic consist of heavy drayage another material would be used. The same applies to bituminous concrete. On grades over 6% and up to 10% we use the hillside vitrified block with splendid results.

*3. Our city being very flat, we are not troubled with maximum grades, in fact, minimum grades give us far more concern than maximum grades.

*4. Pitch filled Brick, 12%; Asphalt block, 10.2%.

*5. Pitch filled Brick, 6%; Asphalt block, 3%.

*6. Grooved or spaced with lath, wooden block up to 5.5%.

*7. Grouted brick, would not recommend over an 8% unless the bulk of traffic is motor driven. Waterbound macadam, 15%; this is the heaviest grade I have observed with macadam.

*8. We have used a brick pavement with tar filled joints laid on a 5% grade, which was objectionably slippery when first laid. This was caused by the tar being poured over the face of the brick to some extent as well as in the joints. After the tar was worn off the surface of the pavement the criticism regarding the slipperiness of the brick ceased. We have laid bitulithic pavement on a 12% grade and it has given good foothold for horses when the surface was properly prepared.

*9. Opinion only, not based on experience. Macadam expensive to maintain on 5% grade.

*10. Max. grade with center strip of rough paving, sheet asphalt, 7%; bituminous concrete, 10%.

*11. Hillside brick, 10%.

*12. Macadam waterbound, 8%, if water is turned off at short intervals.

*13. Hillside brick not considered.

*14. Grades exceeding 5%, heavy traffic, stone blocks or large repressed brick.

The next table, derived from the foregoing table gives the number of cities using as a maximum grade each of the percentages of grade given in the first column. The names of any cities desired can be ascertained by referring to the preceding table:

NUMBER OF CITIES USING MAXIMUM GRADES GIVEN.

Per Cent	Wood Block	Grouted Brick	Sheet Asphalt	Concrete	Bit. Concrete	Penetra. Method Macadam	Water-Bound Macadam
20	—	1	—	1	—	—	—
16	—	—	—	—	—	—	1
15	—	1	—	1	—	—	4
14	—	1	—	1	—	1	1
12	—	—	—	—	1	1	2
11	—	—	—	1	1	—	3
10	—	1	1	1	1	4	3
9	—	1	—	—	—	1	—
8	—	4	—	2	1	2	2
7	1	1	—	2	3	3	—
6½	—	—	—	—	1	—	—
6	1	4	—	1	8	2	—
5	3	7	9	3	3	2	2
4½	—	—	1	—	—	—	—
4	3	1	4	3	1	—	—
3½	—	—	—	1	—	—	—
3	5	1	3	2	—	1	—
2½	3	—	1	—	—	—	—
2	5	1	—	—	—	—	1
1½	—	—	1	—	—	—	—
1	1	—	—	—	—	—	—
0.5	2	—	—	—	—	—	—
0.4	—	—	1	—	—	—	—
Total No. Cities Report	24	24	21	19	20	17	19

TRAFFIC FOR WHICH PAVING MATERIALS ARE SUITABLE.

An inquiry as to the maximum and minimum traffic for which each paving material is suitable, basing the traffic on the number of units per 24 hours and assuming a one-horse vehicle as equivalent to two units brought but few responses, most engineers stating that data have not been obtained. Following are the most definite responses made:

George S. Iredell, Austin, Texas, would arrange the materials in the following order of resistance to wear from traffic:

Wood, brick, bituminous concrete, concrete, sheet asphalt, penetration method macadam, waterbound macadam. Wood, bituminous concrete and sheet asphalt require traffic to keep them in the best condition.

J. H. Dingle, Charleston, South Carolina, is using creosoted wood block on streets of medium and heavy traffic, sheet asphalt and vitrified brick for light to medium traffic with some waterbound macadam on any light traffic residential streets.

John W. Crowley, Davenport, Iowa, is thinking seriously of increasing thickness of asphalt from 1½-inch binder and 1¼-inch wearing surface as present pavements show considerable wear on main thorofares. Creosoted wood in small amount is used on main business street. Brick with pitch and grout fillers seem to be best wearing pavement for heavy traffic. Concrete shows considerable wear, especially in some alleys laid some time ago under old specifications.

Andrew F. Macallum, Hamilton, Ontario, would assign following percentages to materials as to wear, assuming 100 as maximum: Wood block, 100; grouted brick, 60; sheet asphalt, 60; bituminous concrete, 50; concrete, 30; penetration method macadam, 20; waterbound macadam, 10.

Leon F. Peck, Hartford, Connecticut, assigns the following values to maximum and minimum traffic for which each material is suitable, basing the traffic on the number of units per 24 hours and assuming a 1-horse vehicle as equivalent to 2 units:

Material	Maximum	Minimum
Grouted Brick	25,000	2,500
Sheet Asphalt	18,000	2,500
Bituminous Concrete	15,000	2,500
Wood Block	38,000	4,000
Concrete	8,000	800
Penetration Method Macadam	2,500	300
Waterbound Macadam	1,200	200

David R. Lyman, Louisville, Kentucky, assigns the following values:

Material	Maximum	Minimum
Grouted Brick	10,000	0
Sheet Asphalt	7,500	48
Bituminous Concrete	6,000	48
Wood Block	20,000	480
Concrete	5,000	0
Penetration Method Macadam	1,000	10
Waterbound Macadam	250	5

Lawrence E. Curfman, Pittsburg, Kansas, would use grouted brick on heavy traffic main thorofare, concrete on light traffic residence streets; waterbound macadam only for extremely light traffics.

Clarence D. Pollock, San Antonio, Texas, would use grouted brick on medium traffic business streets; sheet asphalt on medium traffic business and residence streets; bituminous concrete on light traffic residence streets; wood block on heavy traffic business streets and never on light traffic streets; concrete, penetration method macadam, and waterbound macadam on light traffic residence streets.

Morton Macartney, Spokane, Washington, would put the paving materials in the following order as to resistance to traffic: Wood block, grouted brick, sheet asphalt, bituminous concrete or concrete, order doubtful; penetration method macadam, waterbound macadam.

Frederick H. Clark, Springfield, Massachusetts, would use materials for traffic as follows: Grouted brick, moderately heavy; sheet asphalt, heavy (retail streets); bituminous concrete, concrete, penetration method macadam, medium; wood block, heavy; waterbound macadam, unfit for auto traffic.

Most Popular Paving Materials.

In response to an inquiry for the names of the principal paving materials in use, arranged in order of amount in use, the information in the following table was received. The fol-

lowing scheme of abbreviations is used with the intention of making them as nearly self-explanatory as possible:

Ab, asphalt block; Ac, asphaltic concrete; Am, asphaltic macadam; Ar, rock asphalt; As, sheet asphalt.

B, brick; Bc, bituminous concrete; Bit, bitulithic; Bm, bituminous macadam; Bo, boulder; Boc, bituminous on concrete base. The differences between bituminous concrete and bituminous macadam and bitulithic were not always made clear in the reports, so that there is probably inaccuracy in some of the returns as to the proper nomenclature. In Philadelphia Bo includes 4.6 miles of "rubble."

C, concrete; Cb, cedar block; Cg, clay-gravel.

D, dolarway.

G, Belgian or other granite block; Gs, granite and scoria blocks.

H, Hassam.

Macadam, see Bm, Wm, Om, Smg, Te.

Om, oiled macadam.

R, Rocmac.

S, stone; Sh, shell; Sl, slag block; Smg, shell, macadam and gravel.

T, tarvia; Te, telford.

W, wood; We, westrumite; Wm, waterbound macadam.

Figures accompanying the abbreviations show the mileage of pavement in the city .

Cities are arranged in alphabetical order. The first column gives name of city. The headings 1 to 12 of columns show order of popularity of the pavements in use, the pavement of largest mileage in each city being first:

PAVEMENTS IN ORDER OF POPULARITY IN EACH CITY

Order of mileage	1	2	3	4	5	6	7	8	9	10	11	12
Abilene, Tex.	Am	Bit	B									
Albany, Ga.	B	W										
Albany, N. Y.	B	G	As	Wm	C	W						
Augusta, Ga	B	Gb	W	C								
Austin, Tex	Bit	B	W	C								
Batavia, N. Y	B											
Boston, Mass	Wm	G	As	W	Bit	B						
Bronx Boro, N. Y.	Ab 61	As 51	G 28	Bc 12	G 17	W 4.4	Ga 1.6	S 0.3	Bm 0.1	B 0.1		
Charleston, S. C.	G	B	Wm	Cg	Bo	Sb	As					
Chickasha, Okla.	A	B										
Cleveland, O.	B	S	A	Wm	W							
Columbia, S. C.	Bit	As	B	W	Bc	C						
Creston, Ia.	Ac	B	C									
Danville, Va.	Bo 9.2	B 3.6	Bit 1.8	Am 1.8	Wm 1.5							
Davenport, Ia	B	A	C									
Dayton, O	B	As	S	G	W							
E. Grand Forks, Minn	S											
Elizabeth, N. J.	Gb	Te	W	B	As							
Elkhart, Ind.	B 12	As 7.6	Om 2	T 1.2								
Erie, Pa.	As 48	B 26	S 3.2	Ab 0.2	W .06	C .03						
Farrell, Pa.	B											
Ft. Smith, Ark.	B 41	C 20	Wm 20	W 0.7	Am 0.3							
Fulton, N. Y.	B	Bm	Wm	C								
Grand Forks, N. D	W	Bm	C	Bit	Ac	S	C					
Grand Rapids, Mich.	B	Bc	As	Ab	C	W	Am					
Greenville, Pa.	B											
Greenville, Tex.	B	Bit	W									
Hamilton, Ont	A	W	Ac	B	C	Wm						

PAVEMENTS IN ORDER OF POPULARITY IN EACH CITY (Continued)

Order of mileage	1	2	3	4	5	6	7	8	9	10	11	12
Hartford, Conn.	As	W										
Hudson, N. Y.	Wm	B	Am									
Jacksonville, Fla.	B 50	Smg 12	Ac 2.4	Ab 2.1	D 0.5	T 0.1	W .06					
Kalamazoo, Mich.	B	A	Ac									
Louisville, Ky.	As	B	Wm	G	Bo	W	Bm	Bc	C			
Meadville, Pa.	B	Ab										
Memphis, Tenn.	As 49	Bm 26	B 11	W 5.4	C 8.5	G 3.4	Sh 0.7					
Minneapolis, Minn.	W	As	B	Am	C	G						
New Orleans, La.	As	B	W									
Norfolk, Va.	A	W										
Omaha, Neb.	As 66	B 55	S 20	Wm 6.4	C 1.5	W .05						
Pasadena, Cal.	Om	As	Ac									
Pawtucket, R. I.	G	Bit	B									
Philadelphia, Pa.	A 504	S 348	Wm 24	B 172	Bm 61	Bo 12	C 1	W 6.2	Sl 6.1	Ab 74		
Pittsburg, Kan.	B	C	Wm									
Pittsburg, Pa	S	As	B	W	Bm							
Portland, Ore	Bit 144	A 106	H 46	Wm 46	C 18	S 9	Ac 4.8	W 2.3	Wo 1	B 0.7	Bm	
Richmond, Ind.	B	C	W									
Rochester, N. Y.	As	B	Wm	S	W							
St. Johns, N. F.	G	S										
Salt Lake City, Utah	As 98	Ar 12	Bit 4.2	Wm 8.7	C 0.7							
San Angelo, Tex.	Boc	W										
Savannah, Ga.	B	Ab	As									
Springfield, Mass.	Wm	Bm	W	B	G	Bit						
Syracuse, N. Y.	As	B	Bm									
Talladega, Ala.	Ac											
Terrell, Tex.	Ar											
Toledo, O.	B	As	S	Wm	Ab	W						
Toronto, Ont	A	Ac	Bit	B	C	R	T	Wm	D	Ab	W	G and S
Trenton, N. J.	As 22	BC 18	B 12	Wm 8.7	S 5.6	C 1.5						
Tulsa, Okla.	As	Ac	B									
Waukegan, Ill.	B	Ac	Om	Wm	C							
Winnipeg, Man	As 107	CB 15	Bit 12	Wm 1.9	C 1.1	W						

Wood Block Pavements.

Wood Used, Treatment, Difficulties Found.

The following table shows the variations in certain specifications for wood block pavements and the experience of cities under their specifications.

The first column gives the names of the cities reporting, arranged alphabetically.

The second column gives the specification for wood used in blocks. While most of the cities specify yellow pine there is considerable variety in the manner of making the specification. This is indicated by the initials S, for Southern; ll, for long leaf; y, for yellow; c, for commercial; and p, for pine, the variations Sllyp, Llyp, Llp, Syp, Sp, Yp, and Cyp, appearing in the table. Other abbreviations used are P, for pine; Np, for Norway pine; Rp, for red pine; Bg, for black gum; Df, for Douglas fir; T, for tamarack.

The third column gives the number of pounds of treatment oil used per cubic foot of timber.

The fourth column gives the average or standard dimensions of blocks with variations when important.

The experience with bleeding of blocks is given in the fifth column and the length of time bleeding continues in the sixth column.

All cities in the table continue using wood blocks with exceptions stated in the numbered notes at the bottom of the table giving reasons for discontinuance.

CONDITION OF WOOD BLOCK PAVEMENTS

City	Kind of Work	Lbs. Creosote Per Cu. Ft.	Dimensions of Blocks	Bleeding Occurs and Lasts How Many Seasons
Abilene, Tex.	None			
Albany, Ga. (1)	Llp	20	3x4x8	Very little 1st summer unless asph. or pitch filler is used.
Albany, N. Y. (2)	Cyp	20	3.5x3 to 4x5 to 10 av. 8	Yes, 2.
Augusta, Ga.	Yp	20	3.5x4x8	Yes.
Austin, Tex. (3)	Llyp	20	3x4x–	Not serious, 1.
Batavia, N. Y.	None			
Beverly, Mass.	None			
Boston, Mass.	Sllyp	20	3 and 4x4x8 3½x3x8	Some, 1.
Bridgeport, Conn.	Llyp	12-20	3x3.5x5 to 8	Yes, 2.
Bronx Boro, N. Y.	Sllyp, Np, Bg, T	20	3x4x5 to 10 av., 8	Yes, 2 on heavy traffic, several on light traffic.
Cambridge, Mass.	Sllp	20	3½x4x8	Occasionally, in first hot weather only
Charleston, S. C.	Llyp	16	3x3x8	Yes, 1.
Chicago, Ill.	Sp, T	16, 14 for heavy traffic	3, 3½ and 4 deep	Yes, about 2.
Chickasha, Okla.	None			
Cleveland, O.	Yp	16 to 20	4 deep	Some, 2.
Columbia, S. C. (4)	Bg	20 to 24	3x5x10	Badly, 2.
Creston, Ia.	None			
Dallas, Tex.	Yp	18	3½x4x8	Some, 2.
Danville, Va.	None			
Davenport, Ia. (5)	Only 1 block.			
Dayton, O.	Yp	20	3x3 or 4	No.
Elizabeth, N. J.	None			
Elkhart, Ind.	None			
Erie, Pa. (6)	Llyp	16	4x4x8	No.
Farrell, Pa.	None			
Ft. Smith, Ark.	Syp	16	4x4x8	Some, 2.
Fulton, N. Y.	None			
Grand Forks, N. D. (7)	T, Np	20	3½x4x5 to 10	Yes, some at 6th year
Grand Rapids, Mich. (8)	Yp	16	3x3x5 to 8	Very little, 5.
Greenville, Pa.	None			
Greenville, Tex. (9)	Llyp	20	3x4x8 av.	Yes, 2.
Hamilton, Ont. (10)	P	20	3	Yes, 1.
Hartford, Conn.	But little, laid 14 years ago and still in good condition.			
Hudson, N. Y.	None			
Jacksonville, Fla. (11)	Only one street, 1,066 sq. yds.			
Kalamazoo, Mich.	None			
Louisville, Ky.	Sllyp	16-20	3x4x8	Yes, usually, 3.
Meadville, Pa.	None			
Memphis, Tenn.	Yp	16	3½x4x8 av.	Slight, 2, remedied by sand sprinkling.
Minneapolis, Minn.	Llyp	16	3½ and 4	None.
New Bedford, Mass.	Only as headers with bitulithic.			
New Orleans, La. (12)	......	20 to 14 for future	3½x4x6 to 10	Yes, sanded.
Norfolk, Va.	Syp	16 to 20 av. about 17	3½ and 4	Yes, 2; little in later pavements. [illegible]
Omaha, Neb. (13)	Yp	16	3½ and 4	Considerable, 2. Not serious, 3rd year.
Pasadena, Cal.	None			
Pawtucket, R. I.	None			
Philadelphia, Pa. (14)	Syp, Np, Bg, T.	P and T, 18, Bg 22	4x3 or 4 x5 to 10, av. 8	Not great, 2.
Pittsburg, Kan.	None			
Pittsburgh, Pa.	Llyp	16	3½x3 to 4x4 to 10 av. 8	Not inconvenient, 1 only.
Plainfield, N. J.	None			
Portland, Ore.	Df	16	4x4x8	Yes, 1.
Richmond, Ind. (15)	Sp	16	4x4	No.
Rochester, N. Y.	Cyp, T	20	3½x3x5 to 10	Yes, 2.
St. Johns, N. B.	None			
Salt Lake City, Utah	None			
San Angelo, Tex. (16)	Yp	20	3x4x8 to 10	No consequence, 2.

CONDITION OF WOOD BLOCK PAVEMENTS (Cont.)

City	Kind of Work	Lbs. Creosote Per Cu. Ft.	Dimensions of Blocks	Bleeding Occurs and Lasts How Many Seasons
Savannah, Ga.	None			
Springfield, Mass.	Llyp	20	3½x4x8	Some, 2.
Syracuse, N. Y.	None			
Talladega, Okla.	None			
Terrell, Tex.	P	....	3½ and 4	Nothing unusual.
Toledo, O	Llyp	16	3½x4x8	Yes, 2 to 3.
Toronto, Ont	Llyp, Np	20	3x4x6 to 10	Yes, about 2.
Trenton, N. J.	None			
Tulsa, Okla.	None			
Waukegan, Ill.	None			
Wilkes-Barre, Pa.	None			
Winnipeg, Man. (17)	Rp	20	3½	No.

1. Albany, Ga., has discontinued use of wood block, because of high cost with asphalt filler, which would not apply with sand filler.

2. Albany, N Y., has discontinued because of tendency to bleed.

3. Austin, Tex., has discontinued, except street car company, because of buckling and expense is greater than other satisfactory pavements.

4. Columbia, S. C., has discontinued on account of expansion and heaving.

5. Davenport has laid but one block and has no special reason for not laying more.

6. Erie has discontinued on account of the high cost.

7. Grand Forks has not laid any since 1912, but gives no special reason.

8. Grand Rapids has discontinued the cost being considered excessive.

9. Greenville, Tex., reports pavements but two years old. Has discontinued because of high cost, poor construction, poor block treatment, and that workmanship, not pavement is at fault.

10. Hamilton reports wood block as the standard pavement for street car tracks and for heavy traffic.

11. Jacksonville has but little and gives no reason for discontinuing.

12. New Orleans considers wood block the best form of modern pavement.

13. Omaha does not now lay on account of prejudice of property owners from past experience.

14. Philadelphia uses wood block, especially where traffic is severe, and where pavement should be noiseless.

15. Richmond, Ind., uses wood block only in small quantities, as the cost is 50 per cent higher than brick.

16. San Angelo, Tex., does not lay new block pavements, buckling being the serious objection.

17. Winnipeg, Man., does not now lay, because of heaving in wet weather.

BRICK LAID FLAT.

Fort Smith, Ark.—Last contract for vertical fiber brick laid flat.

Savannah, Ga.—Only occasionally in repairing.

Pittsburgh, Kan.—5,500 yards vertical fiber brick laid flat with sand filler would be satisfactory for light traffic if it had bituminous filler.

Louisville, Ky.—Just laid small experimental piece.

Boston, Mass.—Yes.

Cambridge, Mass.—Yes.

Omaha, Neb.—Vertical fiber brick laid flat; standard brick on edge.

Trenton, N. J.—No, but seriously considering brick 3 inches deep on medium traffic or residential streets.

Farrell, Pa.—Side exclusively.

Philadelphia, Pa.—No.

Greenville, Tex.—Yes.

Hamilton, Ont.—Yes.

It is the practice to lay vertical fiber brick flat.

GARBAGE AND REFUSE INCINERATORS

CITY	Capacity	Amount of Refuse Disposed of Per Year	Cost of Plant	Cost of Operation, Per Year	Cost of Operation Per Ton of Refuse	Designer and Builder
Talladega, Ala.	None					
Ft. Smith, Ark.	None					
Pasadena, Cal	90 t d	14 t a d	$46,000.00	....	$ 0.75	Fred P. Smith.
Bridgeport, Conn	None					
Hartford, Conn.	None					
Albany Ga.	24 t d	12 t a d	3,500.00	$ 750 00	.....	Nye Odorless, Macon, Ga.
Augusta, Ga.	Installing one.					
Savannah, Ga.	180 t d	30,000 t	125,000.00	15,000 00	40.4 (if run full cap'y)	Heenan, Destructor Co. N. Y.
Chicago, Ill	None					
Waukegan, Ill.	None					
Elkhart, Ind	None	Farmers feed to hogs.				
Richmond, Ind	Worn out. Will build another.					
Creston, Ia.	None					
Davenport, Ia	None					
Pittsburg, Kan.	None					
Louisville, Ky.	None	Now dumping on "swamp land", investigating incinerators.				
Beverly, Mass.	None					
Boston, Mass.	None	Private reduction plant.				
Cambridge, Mass	6 t d	100,000 c y	$12,000.00	City receives $900.00 a year	....	Vulcan Incinerator Co.
New Bedford, Mass	None					
Springfield, Mass.	Garbage reduction 40 t d (private). Rubbish incinerated; ashes to dump.					
Grand Rapids, Mich.	Rubbish and dead animals......		....	... .	....	Engel. Sandstone and Cremator Co., Des Moines, 1898.
Kalamazoo, Mich.	None					
Minneapolis, Minn	125 t d	20,017 t	$50,000.00	$10,300.00	$0.51½	Decarie Incinerator Co.
Omaha, Neb.	None					
Elizabeth, N. J.	None					
Plainfield, N. J.	None					
Trenton, N. J.	60 t d	{ g&r 13,300 t; ash 38,285 t }	$35,148 25	$6,684.48	{ $0.98 g&r coll. 0.88 g&r incin. 0.35 ash. coll. and disp. (Not incl. fixed chgs }	Davis Crematory.
Albany, N. Y.	None					
Batavia, N. Y.	None					
Fulton, N. Y.	None					
Hudson, N. Y.	None					
Bronx, N. Y.	Reduction of garbage. Incin. of refuse.					
Rochester, N. Y.	600 c y r	6,667 t	$85,000.00	$24,444.00	....	Decarie Incinerator Co., Minneapolis, Minn.
Syracuse, N. Y.	Reduction	10,000 t	....	$18,000.00		
Grand Forks, N. D.	None					
Cleveland, O.	Public reduction plant. Rubbish incinerator.					
Dayton, O	None					

CITY	Capacity	Amount of Refuse Disposed of Per Year	Cost of Plant	Cost of Operation, Per Year	Cost of Operation Per Ton of Refuse	Designer and Builder
Toledo, O.	None	Reduction plant	private.			
Chickasha, Okla	None					
Tulsa, Okla	....	....	$10,000 00	$3,800.00	....	McGuire furnace.
	(Gas fuel at 3c p	er 1,000 cf.				
Portland, Ore.	100 16 hr.	41,336 t (11 months)	$100,000 00	$20,781 51 (11 months)	$40.34½ op. and maint.	Fred C. Smith.
Erie, Pa.	50 t 10 hr.	5,100 t	$40,000 00	$5,786 00 (excl. coll. & cart)	$1.12 (excl. int. & dep.)	Morse Boulger Destr. Co.
Farrell, Pa.	None					
Greenville, Pa.	None					
Meadville, Pa.	15 t d	3,130 t	$9,250.00	$2,785.70	$0.89	Dixon Eng. & Const. Co., Toledo, O.
	(Installing force	d draft).				
Philadelphia, Pa.	1,200 t	83,000 t	....	....	....	Penn. Reduction Co., contractor.
Pittsburg, Pa.	Disposed of by c	ontract.				
Wilkes-Barre, Pa.	Private Co.	....	....	....	....	Bennett Garbage Co.
Pawtucket, R. I.	None					
Charleston, S. C.	None					
Columbia, S. C.	None					
Memphis, Tenn.	1. 50 t d	10,209¼ t	$40,000.00	....	$0.40	Dixon.
	2. 50 t d	8,211½ t	19,000.00	....	.50	Dixon.
	3. under constr.	....	....	....	....	McGuire.
Abilene, Tex.	None					
Austin, Tex.	15 t d	1,500 t (Some dumped)	$3,400 00	$960 00 (Excl. repairs)	.64	John A. Thompson Desr. Co., Bldr.
Dallas, Tex.	....	194,400	23,100.00 (present valve)	$7,187 82		
Greeneville, Tex.	Small burning p	lants. No records	of costs and quan	tities.		
Salt Lake City, Utah	Only dead anim	als and part of pa	per, etc.	....	....	Dixon.
Danville, Va.	None					
Norfolk, Va.	50 t d	6,700 t	$35,000 00	$3,858.85	$0.52¼	Decarie.
Seattle, Wash.	Has 11 fills at w	hich all but 65 to	ns a day is dump	ed. Light materi	al amounting to 6	5 tons per day incinerated.
Winnipeg, Man.	1. 60 t 24 hr.	16,210 t	$10,290 00	$10,675 00	$0.666	Toronto Crematory Co.
	2. 100 t 24 hr.	13,763 t	56,900.00	7,685.58	.558	Cy. Engr. Ruttan.
	3. 160 t 24 hr.	30,963 t	131,432.00	25,051 64	.821	Decarie.
St. Johns, N. B.	None					
Hamilton, Ont.	None					
Toronto, Ont.	30 t 24 hr. (Old one burned	23,194 loads and rebuilt, repa	.... irs costing $10,00	$12,400.00 0.00.	$0.27 load, excl. overhead	Local des. built by Dept.

t, tons; d, per day; a, average; cy, cubic yards; g & r, garbage and rubbish; r, rubbish.
Cities are arranged alphabetically by states.

Gas Explosions in Sewers.

Supplementary report from five small cities to paper by N. S. Sprague.

Ordinances.

Memphis, Tenn.—None. No explosions.

Kalamazoo, Mich.—Garage wastes discharged into storm sewers. All oil waste must first discharge into sump pit.

Salt Lake City, Utah—Is preparing a new ordinance to prohibit the discharge of contents of vacuum cleaning machines into the sewer, or other injurious substances.

Toledo, O.—No ordinance on explosive or inflammable discharge into sewers but has with reference to substances interfering with sewage treatment.

South Omaha—None.

Treatment.

None of the five.

System.

Memphis, Kalamazoo, Salt Lake, separate.

Toledo, combined.

South Omaha, both.

Methods of Prevention of discharge of gasoline, etc., into sewers.

Memphis and South Omaha, none.

Kalamazoo, grease traps and sump pits.

Toledo, catchbasins arranged with baffle walls to allow gasoline to evaporate.

Salt Lake, settling tanks from which water is siphoned from bottom of tank.

Locked Manholes.

None of the five.

Sewer Explosions.

Memphis, Kalamazoo, Salt Lake, South Omaha, none.

Toledo, 1 or 2 bad ones due to gas or gasoline fumes and set off by light while making connections.

Ventilation.

None but perforated manhole covers.

REPORT OF THE COMMITTEE ON STANDARD FORMS.

J. C. Hallock, *Chairman, Deputy Chief Engineer, Newark, N. J.*

Some of the members present at this convention may be blessed with inconveniently good memories, and, after listening to the reading of this report, might call attention to the fact that this is the fourth successive annual report presented by the same chairman on the same subject. To discount the criticisms that would naturally come to your minds after hearing the above statement and appreciating, as you all do, the meagre results that have been accomplished, your indulgence is asked while we briefly review the history of this committee and quote a few paragraphs from previous reports. These quotations are principally for the purpose of making more forcible certain points contained in this report in the form of recommendations.

It was at the Grand Rapids Convention in 1911 that your committee reported "* * * we would respectfully call your attention to the fact that such results can only be obtained by the hearty co-operation, not only of every member of our Society, but as well of every municipal engineer in the United States. * * * In extenuation of the seeming lack of interest in this subject on the part of the professional members of the Society, it may be truthfully urged that the men who produce the results to be recorded are *busy* men, generally too busy to keep the records themselves, which are therefore placed in the hands of some clerk. * * * And it is quite evident that our custom of appointing a committee of three 'busy' men year after year, has not produced any startling results. We have always deluded ourselves with the hope that among the many appointed, one would have the leisure and enthusiasm to devote an entire twelve months to this work and

present for discussion at some convention a complete set of blanks. * * * We are convinced that a committee of three, appointed from cities so widely separated that collaboration is impossible except by correspondence, will never produce the desired result unless the chairman takes upon himself an almost Herculean task, which may or may not be approved by the following convention and consequently we recommend: That this convention authorize the Secretary to employ the necessary assistants to prepare data and opinions on the existing forms of records in the various cities represented in the Society and from this collection of data the Secretary can prepare forms to be presented for adoption at the next convention. The Secretary's compensation for this extra work and the salaries of his assistants to be paid from the funds of the Society."

The above recommendation was adopted by the Convention and the Secretary was authorized to expend not more than $750 in the work outlined. As a consequence of this action by the Convention the committee, believing it had been legislated out of existence, received a painful surprise when notified by the President that it had been re-appointed for another year. But, the Secretary of the Society having done some splendid work along the lines indicated and having prepared a report on the same, your committee was enabled to partly save its face at the Dallas Convention in 1912 by recommending the adoption of a suggestion made by the Secretary in his report. This suggestion urged the appointment of a general committee, with sub-committees of experts in each of the several lines, following the ideas embodied in our Committee on Standard Specifications. For some reason, the motive for which cannot now be recalled, it was also suggested that the chairman of the General Committee should be a member willing to serve in that capacity until the adoption by the Society of all the necessary forms. This latter portion of the suggestion proved a boomerang which now compels the chairman to apologize for his repeated appearances in the same role, but this very apology

only emphasizes a certain recommendation made later in this report. The balance of the suggestion made by the Secretary has proven a very wise one and productive of good results. It was to the effect that each sub-committee might appropriately be composed of one expert, these sub-committees together forming a general committee.

However, it was not until the Wilmington Convention last year that any definite results were accomplished and not the least of these was the progress made in establishing among those present an understanding of the aims of the committee. And this same Wilmington Convention did take a most important step and established a mile stone in the history of the committee when it answered the committee's plea for the standardization of units by adopting the four important ones suggested by the Sub-Committee on Uniform Bidding Blanks. Those were in relation to street improvements and the units were the following: *excavation; base* or foundation of pavement, *wearing surface* and *curbing,* each per square yard for construction of pavement; to include everything above the base, sand cushion where necessary, filling of joints with cement grout or other material. In connection with the discussion on the above units, the Secretary of the Society was instructed, by a motion of the Convention, to prepare a pamphlet of this committee's report as adopted by the Society and mail with this pamphlet a circular letter to all the municipal engineers of the United States and Canada, requesting their ideas of the value of this report and asking suggestions as to changes. No replies have been received by the committee.

A unit of *linear foot* of *completed sewer* was also suggested in the bidding blanks for sewer construction but after considerable discussion, no action was taken toward its adoption.

The form for street lighting data was adopted as presented, subject to a future addition to include gas lighting.

The Sub-Committee on Street Cleaning and Refuse Disposal presented, not for adoption but simply as a basis for discussion and suggestion, the form adopted by the American Public

Health Association in 1911. It was requested that suggested modifications should be sent to the committee during the year and no definite action was requested on the form as presented.

This "brief" historical review of the committee's efforts has already tried your patience but it is necessary to chronicle with regret that the President saw fit to continue the same General Committee for another year. This committee, in its turn appointed the following sub-committee with the approval of the President and the reports of these sub-committees are now submitted for your action.

SUB-COMMITTEES.

Street Paving and Repairs—J. H. Sullivan, Boston, Mass.

Street Cleaning and Refuse Disposal—J. T. Fetherston, New York City.

Street Lighting—G. A. Sawin, Newark, N. J.

Sidewalks and Curbs—H. F. Harris, Trenton, N. J.

Sewer Construction and Maintenance—E. S. Rankin, Newark, N. J.

Uniform Bidding Blanks—L. E. Stevens, Grand Rapids, Mich.

It will be noted that although the various sub-committees have something new to report, they are all really progress reports and very noticeable is the unanimous opinion expressed in each one of them that more data must be obtained before final forms can even be recommended for adoption. This demand for data brings the issue squarely before this Convention and would seem to require action on either or both of the following alternatives: This Convention or the next must decide to devote at least one entire session to the discussion of the forms already suggested, modifying or adding where necessity demands; or it must appoint or engage some one person to devote practically an entire year to the collection of the data required by the different sub-committees. Attention is again called to a previous report of this committee where the futility of expecting "busy" men to collect all this data is mentioned, and your committee would recommend that you now give new

life to the action of the 1911 convention, either by requesting the Secretary to continue action along the lines mentioned in the motion passed at that convention, or by enacting new legislation to employ some member of the Society who can give part of his time during the coming year to the collection of the necessary data. This seems to be a requisite for further progress and too much emphasis cannot be placed on the necessity for definite action on this subject by this convention. A vast amount of correspondence will be required and it can be co-ordinated and the data compiled much more successfully by one man than by six if the one can give it the proper attention.

In conclusion your committee would again emphasize the fact that the compilation of data which necessarily forms the ground work or base for further progress is a one man job and it earnestly recommends definite action by this Convention which will authorize the Secretary to give the widest publicity possible to the progress already made by the different sub-committees and to compile the criticisms and suggestions offered upon the present tentative forms. The data thus received can be sent to the sub-committees in time for them to prepare further progress reports for the next Convention.

If we can also at this time adopt another unit or two, the good work started at the last Convention will be kept alive and the committees encouraged to continue their labors.

Respectfully submitted,

J. C. HALLOCK, *Chairman.*
A. PRESCOTT FOLWELL,
MAURY NICHOLSON,
Committee.

REPORT OF SUB-COMMITTEE ON SIDEWALKS AND CURBS.

By HARRY F. HARRIS, *Engineer of Streets, Trenton, N. J.*

In submitting the report of the Sub-Committee on Sidewalks and Curbs, the committee is of the opinion that in outlining a form for reporting sidewalk and curb work, that such a form should not only contain space for recording the details pertaining to such work in each city, in order that information relating to various types of construction should be available, but ample provision should also be made for reporting current prices for all the essential elements, which should be reducible to convenient units, whereby intelligent comparisons of costs as well as practice could be obtained. However, it has been realized that in drafting such a form, it would of necessity have to be much in detail and somewhat cumbersome.

Before attempting to submit a form for consideration, it would seem necessary that a standard bidding blank for curb and sidewalk work should be adopted first (one drawn along the lines recommended for street pavements, where separate bids are received for each different item).

It is therefore suggested that a conference be arranged between the Sub-Committee on Uniform Bidding Blanks, the special committee appointed last year on Sidewalks and Curb, and the present sub-committee. This appears to be the logical step to take before recommending the adoption of any form. Such a procedure would tend to make the work of each committee more definite, and quite in harmony with just what the other two committees were striving for, instead of working along independent lines.

The committee also desires to recommend that the subject of gutters, which is very closely allied with that of curbs and sidewalks, be also included in the scope of their work.

REPORT OF SUB-COMMITTEE ON UNIFORM BIDDING BLANKS.

By L. E. Stevens, *City Engineer, Grand Rapids, Mich.*

The late date of receipt of the Proceedings of the American Society of Municipal Improvements has not given the writer much time to do more than to give a careful study of the proposed Uniform Bidding Blanks as presented at the last convention.

The writer, as chairman of the sub-committee which has this matter would like to know whether the following items are to stand as printed:

Under Improvements.

Should not items (27) to (30) inclusive, state the width of gutter, as this varies with different types of surfaces, and in different sections of the country.

Under Improvements.

Item (2) in the writer's opinion should be per lineal foot of roadway instead of per square yard, as invariably the grading in such cases—except in some cases of resurfacing—covers a width greater than the paved roadway. However, in reporting the cost of pavements this is easily reduced to a cost per square yard.

Under Sewers.

The statement following item (24) should precede item (13).

Items (57) to (76) inclusive, should be per lineal foot of trench instead of per square yard or square foot. Specifications to provide for the payment at the prices bid under the separate items, for replacing all pavements that is damaged by reason of the trench work, thereby protecting the city from additional expense due to the caving of poorly braced trenches or careless removal of the sheeting.

A square yard basis of payment for replacing pavement, would tend to encourage poor trenches as the contractor would be sure of payment for every yard replaced, and usually at a

good price, while payment per lineal foot of trench would encourage the prevention of caving or settlement as the smaller width replaced the better for the contractor.

The writer's experience has been that the payment per lineal foot for replacing pavements over trenches results in better trench work.

Would it not be well to take these matters up at the convention and make such changes as are deemed fit, and have copies of the proposed blanks sent out by the Secretary with the request for comments and criticisms as has been done with the form for improvements.

Any suggestions or recommendations that you have to offer will be appreciated, as the question now stands, I do not see wherein a report recommending the adoption of either form can be made without considerable more data.

DISCUSSION.

Mr. Hallock: The first thing is in connection with combination curb and gutter. Do you wish the width stated?

The President: I am quite positive that was called for, but was left out in the printing. At least, it was intended to be there.

Mr. Hallock: The next is in item 2, that it should be lineal foot of roadway, instead of square yard, that is, earth excavation in improved streets.

The President: I hesitate to disagree with Mr. Stevens, but if we have the width of street 30 feet, we know the number of square yards, and he can ask for bids per square yard. The Grand Rapids form is per lineal foot, and it takes in everything on an improved street; but lineal foot of street might mean 20 feet and it might mean a 50-foot pavement. The engineer can easily put it in square yards, and I believe he should do it.

Mr. Hallock: The next is that the statement following item 24 should precede item 13.

THE SECRETARY: That is a typographical error, and will be changed.

MR. HALLOCK: Next that items 57 to 76, inclusive, should be per lineal foot of trench instead of per square yard or square foot.

THE PRESIDENT: I talked with Mr. Stevens about that. I believe it is the Society's intention to make the blanks as uniform as possible, and I told Mr. Stevens I believed the sewer specifications would cover the width of trench that would be paid for, and, if not, he could include in his specifications that pavement will be paid for, for replacing so many feet in width, and then if they go outside of that, they do not get anything for it. We had trouble in Grand Rapids. The contractor had it per square yard, and made as many square yards as he could.

THE SECRETARY: I want to emphasize the committee's recommendation that this loose-leaf form of specifications be adopted. I adopted them myself one year before this association was formed, and the method is still in operation in Indianapolis, and is one of the most convenient things that ever got into the engineer's office. They can be put in pocket form and the inspector can put them in his pocket, and he doesn't have to carry useless material. It is very convenient also for the engineer in making up his specifications.

MR. HODGDON: I think they might be printed on a grade of paper that would permit of blue prints being made from it. We could then send a blue print to anybody we wanted to.

REPORT OF SUB-COMMITTEE ON STANDARD FORMS FOR SEWER CONSTRUCTION AND MAINTENANCE.

By E. S. RANKIN, *Engineer of Sewers and Drainage, Newark, N. J.*

Your committee has assumed that in order to encourage the general adoption of standard forms it is necessary to avoid too

much detail, while at the same time presenting sufficient facts and figures to permit of the easy comparison of reports from different cities. It has also assumed that co-operation and substantial agreement between this Society and the United States Census Bureau would result in a decided advantage to all parties interested and materially assist in accomplishing the desired result.

Acting on these two assumptions, your committee, after consultation with the Chairman of the General Committee, prepared three tentative forms, which were submitted to the Director of the Census at Washington for criticism and suggestions.

Form 1 for reporting main details of all sewers constructed during the year.

Form 2, in duplicate, a condensed form for reporting

(*a*) Sewers built during year;

(*b*) Entire sewer system.

Form 3, for reporting annual details and cost of maintenance and repairs.

After some correspondence forms 1 and 2 substantially as here presented were agreed upon as being satisfactory.

Form 3 presented more difficulties, and in the limited time remaining it seemed unwise to submit this form for final adoption.

Your committee therefore recommend the adoption by the Society of Forms 1 and 2 and urge that all cities having representatives in this Society use these forms in making their annual reports.

Form 3 is not recommended for adoption, but is submitted for the consideration and suggestions of the Society with particular reference to the following points:

The Director of the Census recommends the separation of the main heading "Flushing" and "Cleaning." Your committee feels that these two processes being so intimately connected both in their operation and purpose, should be listed under one heading.

The Director again suggests that the main headings "Inspection and Complaints" and "Miscellaneous Items" should be placed as sub-heads under the other main heads. Your committee prefers the present arrangement.

It has also been suggested that Stable and Garage Expenses should form a separate subdivision of costs. In the form as submitted, these are supposed to be included in the general costs of labor and supplies in order to simplify the form.

It should be added that the Director recommends an additional form showing the method of financing sewer construction and also that a statement should be made showing the present value of the Sewer System.

Lack of time also prevented the preparation of a form for Sewage Disposal.

Expressions of opinion are requested on

1. Should there be one or two main headings for items "Flusing and Cleaning?"
2. Should "Inspection and Complaints"
    a. remain as a main heading?
    b. be distributed as sub-heads under the other main heads?
    c. be distributed under present main and sub-heads?
3. Should "Miscellaneous Items"
    a. remain as a main heading?
    b. be distributed as sub-heads under the present main heads?
    c. be distributed under present main and sub-heads?
4. Should "Stable and Garage Expenses"
    a. be included in "Labor" and "Supplies" as per form submitted?
    b. appear as additional sub-heads?

Remarks and suggestions.

ADOPTED BY THE AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.

Form 1. FOR REPORTING MAIN DETAILS OF ALL SEWERS BUILT DURING THE YEAR

LOCATION			SEWER				
Street	From	To	1 Material	Length in Feet	Size	2 Depth in Feet	Cost Per Foot

3 Nature of Soil	HOUSE CONNECTIONS				MANHOLES		BASINS		INLETS		FLUSH TANKS	
	Number	Length	Size	Cost	Number	Cost	Number	Cost	Number	Cost	Number	Cost

4 OTHER ITEMS		TOTAL COST	5 SYSTEM	6 REMARKS	7 CONTRACTORS	7 DATE OF FINAL ESTIMATE
Character	Cost					

1. Brick, pipe, concrete, etc.
2. Maximum and minimum cuts should be stated.
3. Particular note should be made as to water encountered
4. Rock, extra concrete, brick, etc.
5. House sewage, storm water or combined.
6. This column may be used to note surface improvements, whether graded or paved street, etc.
7. These two columns are of local interest only and may be omitted.

Adopted by the American Society of Municipal Improvements.

FORM 2—CONDENSED FORM FOR REPORTING SEWERS BUILT DURING YEAR. THE SAME FORM TO BE USED FOR REPORTING ENTIRE SEWER SYSTEM.

Material	House Sewage. feet.	House Sewage. miles.	Storm Water. feet.	Storm Water. miles.	Combined. feet.	Combined. miles.	Total. feet.	Total. miles.
Stone								
Brick								
Concrete plain								
Concrete reinforced								
Concrete pipe								
Vitrified pipe								
Cast iron pipe								
....								
....								
....								
Total								

	Number.	Length.
House Connections		
Manholes		
Catch Basins		
Inlets		
Flush Tanks		
....		
....		
....		
Total Cost $		

NOTE—Sewers built of two or more materials, as for example brick and concrete, should be classified under head of material predominating.

Adopted by the American Society of Municipal Improvements.

FORM 3—FORM FOR REPORTING ANNUAL COST OF MAINTENANCE AND REPAIRS.

A—Flushing and Cleaning.

	Number	Length	Cu. Yds.	Cost: Over-head charges	Cost: Labor	Cost: Equipment and Supplies	Cost: Total	Remarks
*Large Sewers								
*Small Sewers								
House Connections								
Manholes								
Basins								
Inlets								
Flush Tanks								
....								
....								
Total								

*Large sewers refer to sewers large enough to be entered and cleaned by laborers from the inside. Small sewers to those not large enough to enter.

B—Repairing.
Brick sewers
Concrete sewers
Pipe sewers
House Connections
Manholes
Basins
Inlets
Flush tanks
....
....
Total
C—Pumping.
Gallons
Lift

	Cost				Remarks
	Overhead charges	Labor	Equipment and Supplies	Total	
Op"rating Expenses,					
Repairs					
Total					

D—Inspection and Complaints.

	Overhead charges	Labor	Equipment and Supplies	Total	Remarks

E—Miscellaneous Items.
Character
....
....
....

DISCUSSION.

MR. RANKIN: It might be well to have these pinned up here so that all may examine them. Form 2 is in practically the same shape as submitted two years ago. It is also similar to the one used by the Census Bureau. While none of these reports are in final shape, it would be well to act on them, so as to make definite progress.

MR. CARPENTER: Is the committee familiar with the work of the Boston Society of Civil Engineers along this same line? They had a committee a number of years ago which worked for several years upon such a form. That form has been quite widely circulated in New England, and I think has been adopted by the Census Bureau. Within a year the Illinois Society of Engineers recommended adoption of a form for re-

porting sewerage statistics, and referred to the form adopted by the Boston Society, and recommended its adoption. It is desirable that our forms be in accord, if possible.

MR. FOLWELL: The form we sent around two years ago was practically the form of the Boston Society of Engineers. I have been watching that for some years, and was hopeful we would get something in accord with it. Mr. Rankin states his form is in accord with that of the Census Bureau, and Mr. Carpenter says the Census Bureau adopted the Boston Society's form so I think we can take it for granted there is no great variance between the Boston form and that the committee has here.

MR. CARPENTER: That is all true, only we shouldn't take it for granted.

MR. HALLOCK: As to blank on sewer construction, there was discussion last year as to depths of trench. As I remember it, we made the depths jump two feet at a time, starting at four, going six, eight, and so on.

MR. RANKIN: I do not believe there was any objection to that last year; that was decided upon as being correct.

THE PRESIDENT: The committee only recommended we adopt the unit for measuring sewers.

MR. FOLWELL: Why was it that the materials in instances of the excavation of rock and also pavement removal were not classed with Material of Excavation, rather than for miscellaneous classification at the end?

MR. RANKIN: As far as the pavement goes, I suppose it is because of my own experience. As a rule, our sewers are built in unpaved streets, and it is rather a rare occurrence to have pavement to remove—and I thought that might come under Remarks. We have a column for Nature of Soil, and in a footnote we say to put the rock excavation under Other Items. That was because of the extra cost of rock excavation; as a general rule where rock is encountered there is either a bid price or an allowed price.

MR. FOLWELL: In most trenches rock and soil both occur, and it seemed natural to think they would be classed together, at least in parallel columns.

MR. RANKIN: If you encounter rock, our idea was to note it in the column Nature of Soil, but the cost of the rock we would put in this other column headed "Other Items."

MR. FOLWELL: Were there any explanations to accompany this to explain one or two items? One is, as to what point the depth of the sewer is to be taken to, whether to the top of the sewer, to the invert, to the under side of the sewer.

MR. RANKIN: Our practice is to always consider the depth to what we call the water run, the invert of the sewer. It would be well to put such an explanation in.

MR. POTTER: The point as to the depth of the sewer is important. In going over some plans I am now working on, I find that some of the plans show the invert, some show the top of the sewer, and some the middle of the sewer, and I believe it would be well if we could have a standard on this.

MR. RANKIN: I would feel the depth should be the extreme depth, but it is our custom to call the depth to the flow line or invert. A footnote could be added taking care of this.

MR. FOLWELL: Another important point is whether there is any difference between this and the Boston Society of Civil Engineers' specifications. Perhaps Mr. Carpenter has examined into that.

MR. CARPENTER: I have had no opportunity to study the work of the committee, but I understand the committee is not familiar with the work of the Boston Society. I feel, therefore, the committee should be given an opportunity to study the work of the Boston Society before we finally pass on this matter, for we shall both lose by having independent forms if we can agree upon one. The Boston Society has not covered anything in the way of that blue print, and I see no objection to that. As to the form of reporting sewerage statistics of the Boston Society, it may be thought that in their summary

there are too many items, but the same explanation might be made that Mr. Folwell made this morning as to our form of contracts. It is not expected that each engineer shall fill them all in, but it was the endeavor to give sufficient items to cover the majority of cases.

MR. EDDY: I would like to say a few words as to the work of the Sanitary Section of the Boston Society of Civil Engineers. Six or eight years ago a committee was appointed to devise forms for statistics for sewerage work, and these forms were adopted by the Boston Society. There are some of the blanks here. These forms cover not only sewerage, the collecting system, but also pumping statistics and sewage treatment statistics. On account of the relatively large number of methods of treating sewage, they are more or less voluminous in the pamphlet form.

The original committee's work was supplemented by the work of another committee, which attempted to compile statistics, and in its first report compiled statistics from some thirty cities and towns. This committee was reappointed and extended the work another year, reporting on some fifty cities and towns. Those reports are in print and are in the files of the Journal of the Association of Engineering Societies.

Five or six years ago the Census Bureau took this matter up, and the committee of the Boston Society co-operated with the officials of the Census Bureau, the result being that the Census Bureau adopted, in considerable measure, the forms previously adopted by the Boston Society, and in the census report entitled General Statistics of Cities, 1909, you will find the first and only report of the Census Bureau giving statistics in this form in detail. I think if it is possible for us to agree on forms, it would be beneficial to all concerned. The fact that the Census Bureau has established a set of forms leads me to think we would do well to follow the form of the Census Bureau so far as is compatible with the results we desire to obtain.

The blue print contains figures largely on cost of building sewers, which has not been included in the work of the Boston Society. I think that is desirable, and that the committee is to be congratulated on the work it has undertaken. There is no reason why a committee of the Boston Society might not be authorized to confer with your committee, if you care to continue the investigation.

MR. FOLWELL: Am I correct in thinking that I recall, within the last few months, the Boston Society publishing a statement in connection with this, that considering the fact that the Census Bureau had practically taken over the form of that Society, and was going to carry out the work of collecting statistics on this form, the Boston Society had decided to leave the matter entirely in the hands of the Census Bureau?

MR. EDDY: I believe that is correct.

MR. FOLWELL: And our Committee state that they have submitted these forms to the Census Bureau, and they are in accord with those the Census Bureau is to use; so there could be very little disparity between our forms and those of the Boston Society.

MR. RANKIN: Of course, duplication of forms would be worse than useless. This blue print form seems new, and as it has been approved by the Census Bureau, it might be well for us to adopt that. Form 2 is practically the same as a certain part of the Boston Society's form, and is also very nearly identical with the form used in this report to which Mr. Eddy has referred, and with which I am familiar. We recommend Forms 1 and 2 for adoption, and submit a tentative form No. 3. I have corresponded with the Director of the Census, and we do not agree on certain details, and we present this Form 3 in the hope that the members of the Society will criticise it and give us the benefit of their views, that we may make a final report next year. Still another form for reporting sewage disposal should be made, but lack of time has prevented our taking it up. I hope next year's committee can. The Director

of the Census suggested that in Form 1 there be added a number of columns showing the methods of financing this construction. I replied that it seemed to me the form was long enough, and it might be better either to explain in the context how these sewers were financed, or to have still another form showing that in detail.

MR. MATTHEW BROWN: I should like to ask a question. Suppose I have a sewer, say 11,000 feet long, and in some places we have to go through a hill, where it will be 24 feet deep. The material is practically the same from top to bottom. At what ratio should the cost of that increased depth be figured as you go down in that trench? Is there any one who can give me a basis on which to figure the difference in depth?

MR. FOLWELL: I do not think you could give any fixed amount per unit of two feet. There is apt to be, and there is, in most trench work, what you might call a critical point. If it is all hand work, a man can throw dirt out of a trench up to 8 or 10 feet; if it goes beyond that, you have to stage it out, and it has to be handled twice. That is the critical point. You might have a unit in grades from 4 to 6 feet, from 6 to 8, and possibly from 8 to 10, but there you would jump. I don't think you could take a given sum, and say you could use that every two feet. You could have it so much from 2 to 4, so much from 4 to 6, so much from 6 to 8, and so on. Half the bids on sewer work are given in that form.

THE PRESIDENT: Isn't it a fact there would be only one or two items on any one sewer as to that?

MR. FOLWELL: Yes. And again, if there were a long line of sewer in level country, and the sewer had to fall a little more rapidly than the ground, say it was 8 feet at the upper end and 12 feet at the lower end, if it were all let in one contract, I do not think it would be necessary to make the variation. But take a place where they are letting sewers all over town, they might vary from 6 to 12 feet in a short distance. It might go through a hill, and vary from 6 to 12, and back to

8 at the other end. There it would be impossible for a contractor to do justice to himself in bidding a lump sum per foot of sewer regardless of depth. No man except with the use of a large amount of higher mathematics could arrive at an average cost, and it was in such cases as that where we arranged for two-foot intervals.

MR. HODGDON: Do you usually let these sewers without classification, and let the contractor assume his own responsibility as to that?

MR. FOLWELL: Of material?

MR. HODGDON: Yes, sir.

MR. FOLWELL: That is done in some cases, and I think some cities do it to avoid trouble with the engineer, and to avoid lawsuits over the classification. The matter of classification is a difficult one, and it has not been solved, and considering the number of combinations of classifications run across, it will probably never be solved. As I remember, the specification adopted by this Society offered two classifications, earth and rock, and the attempt is made to define rock as correctly as possible, and anything that is not rock is earth. That leaves the question, whether you will include under earth, hard pan. It is difficult to handle.

THE PRESIDENT: In railroad work we classify it as rock and earth, and anything not rock is earth.

MR. TALBOT: The classification in West Virginia on the Norfolk & Western is hard pan, loose rock and solid rock. Anything you could plow with four horses was considered hard pan; but there is confusion there. It would only confuse the engineer.

REPORT OF SUB-COMMITTEE ON STREET CLEANING AND REFUSE COLLECTION AND DISPOSAL.

By J. T. Fetherston, *Chairman.*

At the 1913 Convention a "Standard Form for Statistics of Municipal Refuse," adopted by the American Public Health Association in 1911, was presented for discussion.

A Special Committee of the Sanitary Engineering Section of the American Public Health Association reported in September, 1913, on statistics gathered according to the standard form for the year 1912. Seventy-five cities were requested to provide information, and eight replied, of which only five returned the form made out as requested. These five cities were Washington, D. C., New York, N. Y., Chicago, Ill., Milwaukee, Wis., and Salem, Mass. Of the five forms received from the foregoing cities, two were incomplete. Thus, only 6.7 per cent. of the cities communicated with made a complete return on the standard form.

From past experience of the Society, it is apparent that detailed statistics regarding street cleaning, refuse collection and refuse disposal are not available today in such form as will be of service in analyzing the reports and deducing therefrom facts which will be beneficial for municipalities. It is likewise evident that a preliminary campaign of education will be necessary to awaken cities to a realization of the necessity for and advantages of standard forms of statistics. Your sub-committee has therefore drafted a very general set of question covering street cleaning and refuse collection and disposal, for the purpose of compiling such information as cities can most readily furnish, with the object of eventually providing a more detailed set of forms, after the advantages resulting from the general statistics have been realized by all cities, particularly those represented in the membership of the Society.

The answers to the general questions which follow will enable engineers, superintendents and mangers interested in street cleaning work to deduce from the statistics certain broad relations between definite physical facts (pavement areas or city areas), population, employees, work quantities, and costs, which will be of service in evaluating street cleaning activities among various municipalities. The suggested questions are herewith presented for examination and discussion.

General Data On Street Cleaning, Refuse Collection And Disposal.

General Information:

City of........................ Year.............

Area................. Sq. Miles

Population... . ...

Street Cleaning Data:

1. Length of streets subject to regular cleaning, in miles.

2. Vehicular traffic area (in square yards) subject to regular cleaning.

3. Sidewalk area (if any) in square yards, subject to regular cleaning.

4. Areas (in square yards) of different classes of pavement subject to regular cleaning.

Sheet asphalt,	....	Cobble,	....
Asphalt block,	....	Brick,	....
Granite block,	....	Wood block,	....
Medina block,	....	Iron Slag,	....
Belgian block,	....	Concrete Mac'dm	....
Trap,	....	Bituminous,	....
....	....	....	....
....	....	....	....

5. Average number of single cleanings of traffic area per year.

6. Average number of single sidewalk cleanings per year.

7. Amount (in cubic yards) of street sweepings collected per year.

8. Methods of street cleaning in operation:

(a) Hand broom..
(b) Horse sweeping machines.......................................
(c) Hose flushing..
(d) Horse machine flushing...
(e) Horse machine sprinkling..
(f) Motor machine sweeping..
(g) Motor flushing or sprinkling.....................................
(h) Other methods...

9. Method of removing and disposing of street sweepings:

(a) By contract..
(b) By city force and equipment......................................
(c) Method of disposal...

10. Number of workmen (sweepers, laborers, drivers, etc., excluding supervisory force) employed in cleaning the streets by different methods:

(a) Hand broom, ...
(b) Horse sweeping machines, ...
(c) Hose flushing, ...
(d) Horse machine flushing, ...
(e) Horse machine sprinkling, ...
(f) Motor machine sweeping, ...
(g) Motor flushing or sprinkling, ...
(h) Other methods, ...

11. Total force employed in street cleaning, and salaries or wages, including supervisory force, clerical force, and workmen:

No. $

12. Average hours workmen employed, per day ...... per week ....

13. Force employed Sundays and holidays.

14. Seasonal variations in force, increase or decrease, winter and summer.

15. Is street cleaning work performed by the city or by contract?

16. Total cost per annum for:

(a) Street cleaning proper, $...............
(b) Removal of street sweepings, ...
(c) Disposal of street sweepings, ...

(Note kinds of expenses included above,—supervision, labor, renewals, supplied, interest and depreciation Strike out those not included, and if possible give details of charges).

17. Note any revenues derived from street sweeping or disposal of street sweepings.

REFUSE COLLECTION DATA:

1. Kind of refuse collected (mark with x):

(a) Household refuse:
Ashes,
Rubbish,
Garbage.

(b) Trade or industrial refuse.

(c) Dead animals.

(d) Others solid wastes, (specify kind).

2. Household refuse:

(a) Is householder required to separate refuse into classes, and what classes?

(b) Types of receptacles used.

(c) Frequency of removal.

(d) Location of receptacles and where placed for removal.

3. Household refuse collection:

(a) Is collection made by contract or by City?

(b) Type, number and capacity of vehicles used for collection.

(c) Time of collection (night or day hours).

(d) Population from which household refuse is collected.

(e) Amount (cubic yards) of household refuse collected for year.
Ashes............ Rubbish............ Garbage............

(f) Number of laborers and drivers employed in collecting and removing household refuse.

(g) Total number of men of different grades (superintendents, foremen, clerks, laborers, drivers, hostlers, etc.) employed in household refuse collection, and their daily wages:

No. $

(h) Number of hours refuse collectors work per day..........., per week ....

(i) Are collections made on Sundays and holidays?

(j) Total cost of collecting household refuse for year.

(Note the kinds of expenses included in the above,—supervision, labor, repairs, renewals, supplies, interest and depreciation. Strike out those not included, and if possible give details of charges).

(k) Is householder taxed directly for collection and removal of household refuse, or is the work paid for out of general tax levy?

REFUSE DISPOSAL DATA:

1. Methods of refuse disposal.

(a) Household refuse:
Ashes ....
Garbage ....
Rubbish ....

(b) Trade or industrial refuse.......................................
(c) Dead Animals ....
(d) Other solid wastes ....

2. Locations, types and capacities of disposal works.

3. Amounts of refuse (in cubic yards and tons) disposed of during year by various methods.

	Cubic Yards	*Tons*	*Method*
Ashes,			
Rubbish,			
Garbage.			

4. Number of laborers and other grades of employees engaged in the disposal of refuse, with salaries or wages paid.
No $

5. Number of hours men work on refuse disposal, per day ...... per week ....

6. Are men employed Sunday and holidays?

7. Total cost of refuse disposal for the year.

(Note kinds of expenses included in the above,—supervision, labor, repairs, renewals supplies interest and depreciation. Strike out those not included, and if possible give details of charges).

8. Are householders taxed directly for refuse disposal, or is work paid for out of general tax levy?

9. Are any revenues derived, directly or indirectly, from the disposal of refuse? Give details.

REPORT OF COMMITTEE ON STANDARD SPECIFICATIONS.

Your General Committee on Standard Specifications, having held almost continuous sessions during the week and having received and discussed and held hearings on the reports submitted by the several sub-committees, beg leave to submit complete specifications as modified in some instances by conference between the sub-committees and the General Committee, as follows:

1. Stone Block Paving—H. H. Schmidt, Chairman.
2. Brick Paving—E. H. Christ, Chairman.
3. Concrete Paving and Concrete Sidewalks—C. A. P. Babcock, Chairman.
4. Broken Stone and Gravel Roads—A. H. Blanchard, Chairman.
5. Asphalt Paving—Francis P. Smith, Chairman.
6. Sewers—E. J. Fort, Chairman.

These specifications, for the most part, are corrections of typographical errors in the specifications heretofore printed and a harmonizing of discrepancies between the specifications of the A. S. P. S. and this Association, where specifications had been adopted by the respective Associations, and certain other changes which the sub-committees and the General Committee have considered improvements, tending to clarify the specifications and more definitely stating certain requirements in said specifications, about which there had been more or less controversy and ambiguity. Your committee will make a verbal statement showing the changes in the several specifications submitted from those heretofore adopted, and would request the chairmen of the respective sub-committees to supplement such statement by further explanation, in order that the Convention may know what is embodied in the way of modifications in these specifications from those heretofore adopted.

As far as your General Committee has been able to learn in regard to the specifications enumerated above, all questions of serious disagreement over points of contention have been adjusted.

Specifications for sewers are presented practically as printed in the 1913 proceedings, which embodied practically the suggestions made at the last meeting. There have been, however, objections made to Sections 205 and 210 as printed. There not being time at present to thoroughly discuss these sections, the committee recommends that the specifications as presented be approved and adopted with the exception of the two sections mentioned above. That these two sections be printed in their regular place, each one to be followed by an alternative section, which will be sent to the Secretary by Mr. Parmalee and that these two sections be finally determined upon at the next meeting.

In regard to specifications for Wood Block Paving, E. R. Dutton, Chairman, your General Committee would recommend that the specifications as herewith submitted be printed in the Annual Proceedings and that the consideration of adoption of these specifications go over until the next annual Convention.

In regard to Bituminous Paving, Linn White, Chairman, your committee requests permission to make a supplemental report either this evening or at tomorrow's session, which report it is hoped may present an agreement of all the conflicting opinions in the Society on this subject.

NOTE—Here follows the presentation of the several specifications recommended in the order given above with a verbal statement of the modifications contained therein from previous specifications on the same subject.

Respectfully submitted,

GEO. W. TILLSON, *Chairman.*
E. A. FISHER,
M. R. SHERRERD,
Committee.

REPORT OF SUB-COMMITTEE ON SPECIFICATIONS FOR STONE BLOCK PAVING.

To the Committee on Standard Specifications:

Gentlemen:

Your Sub-Committee on Stone Block Paving Specifications reports as follows:

We recommend some changes in the specifications for stone block paving, adopted by this association at its meeting at Wilmington, Delaware, held Oct. 7th, 8th, 9th, and 10th, 1913.

It is essential that the crushing strength of the granite be fixed, and it is therefore suggested that a minimum of 20,000 pounds crushing strength be specified.

As a result of numerous tests made on Granite Paving Blocks which have been in actual use, it has been found that the toughness of 11 before specified is entirely too high. A number of granites which have given good satisfaction have tested as low as 8 for toughness, so that the specification has been changed from 11 to 9.

Very little data is available as to the tests required for granite paving purposes, and a further investigation of this subject is desirable.

The former specification called for a depth of block not less than five (5) nor more than five and one-half (5½) inches deep. The general practice has been to obtain as nearly as possible a block five (5) inches deep, and therefore it is suggested that the limits of the depth be fixed at not less than four and three-quarter (4¾) inches, nor more than five and one-quarter (5¼) inches.

It has been the practice in a number of cities for several years, to use a napped or recut granite block. Many of our larger cities have a considerable mileage of granite block pavement, consisting of old and worn blocks approximately twelve (12) inches long, four (4) inches wide, and eight (8) inches

deep. Often these blocks can be redressed to conform to the specification for new blocks, or where that is considered too expensive, they can be cut in two and relaid with the new face upward. A great improvement over the old pavement is thereby effected at a considerable saving over the cost of new granite blocks. Care should be exercised, however, in doing work of this nature, to use only granite of a character which makes a satisfactory paving block, as many of the old granite blocks were made of granite which is not suitable for paving purposes.

The specification adopted in 1913 called for a cushion course of sand varying in depth from one (1) to two (2) inches. We believe that this cushion course should be reduced to a minimum, and it is suggested to obtain a cushion course averaging not more than one (1) inch in thickness. This will require that the surface of the concrete is finished more accurately than has often been done in past practice.

No change has been made in the character of the gas tar pitch filler, although some tests have been added, but the asphalt filler has been changed somewhat, and we believe its character will be improved by the change.

Further investigation regarding bituminous filler is desirable.

The changes outlined in this report have been incorporated in the proposed specification, together with some other slight changes and additions, and your sub-committee hereby recommends the adoption of the revised specifications presented herewith.

H. H. SCHMIDT, *Chairman,*
L. D. CUTCHEON,
M R. SHERRERD,
WILLIAM A. HOWELL,
JOHN E. RAMSAY,
Committee.

SPECIFICATIONS FOR STONE BLOCK PAVING.

Adopted October 8, 1914.

NOTE—These specifications will be modified from time to time to keep them fully up to date. Suggestions as to modifications or additions are solicited and should be sent to the Secretary, or to H. H. Schmidt, Chief Engineer, Bureau of Highways, Brooklyn, N. Y., Chairman of the Sub-Committee on Specifications for Stone Block Paving, and George W. Tillson, Boro Hall, Brooklyn, N. Y., Chairman of General Committee on Standard Specifications.

NEW GRANITE PAVING BLOCKS.

1. The paving blocks shall be of medium grained granite, showing an even distribution of constituent minerals, of uniform quality and texture, without seams, scales or discolorations showing disintegration, free from an excess of mica or feldspar, and equal in every respect to the sample in the office of the Engineer.

The granite shall have a crushing strength of not less than twenty thousand (20,000) pounds per square inch, combined with a uniform structure and toughness. The toughness shall be not less than nine (9), as determined by the method employed at the United States Department of Agriculture, Office of Public Roads.

CERTIFICATES AND SAMPLES.

2. Contractors shall file with the Engineer at or before the time of bidding, a certificate showing the name and location of the quarry from which it is proposed to obtain the blocks, also a certified copy of a report from the United States Department of Agriculture, showing the crushing strength and toughness of the granite which it is proposed to use.

The following samples of specification blocks and granite of the kind it is proposed to use, shall be filed with the Engineer on or before the date of bidding:

Three (3) specification granite blocks.

Three (3) granite cubes measuring three (3) inches on a side, accurately cut and finely dressed, for testing purposes.

3. The blocks shall be of the following dimensions: Not less than eight (8) nor more than twelve (12) inches long on top; not less than three and one-half (3½) nor more than four and one-half (4½) inches wide on top; not less than four and three-quarters (4¾) nor more than five and one-quarter (5¼) inches deep.

The blocks shall be so dressed that the faces will be approximately rectangular in shape, and the ends and sides sufficiently smooth to permit the blocks to be laid with joints not exceeding one-half (½) inch in width at the top, and for one (1) inch downward therefrom, and not exceeding one (1) inch in width at any other part of the joint. The top surface of the block shall be so cut that there will be no depressions measuring more than three-eighths (⅜) of an inch from a straight edge laid in any direction on the top and parallel to the general surface thereof.

Not more than one drill hole shall show on the head of the block, and none on the ends. An allowance of not over an average of one block showing drill hole on the side, will be permitted to a square yard of pavement.

Care shall be exercised in handling the blocks, so that the edges and corners shall not be chipped or broken, as blocks otherwise acceptable may be rejected on account of spawling.

4. The blocks shall be sorted and laid in courses of uniform width, except in special cases, as may be ordered.

NEW SANDSTONE PAVING BLOCKS.

5. The paving blocks shall be of sound, hard sandstone, free from clay, seams, or defects which would injure them for paving purposes, of uniform quality and texture, and equal in every respect to the sample in the office of the Engineer.

The blocks shall be of the following dimensions: Not less than eight (8) nor more than ten (10) inches long on top; not

less than three and one-half ($3\frac{1}{2}$) nor more than six (6) inches wide on top; not less than four and three-quarters ($4\frac{3}{4}$) nor more than five and one-quarter ($5\frac{1}{4}$) inches deep.

RECUT OR REDRESSED PAVING BLOCKS.

6. When the use of blocks recut from old paving blocks is permitted, such blocks must comply with the specifications for quality of stone, as required for new blocks. The dimensions may be varied, depending upon the size of the old blocks which are to be redressed, and the character of the pavement which it is sought to obtain.

SUB-FOUNDATION.

7. Any soft or spongy material below the sub-grade, shall be replaced with sand, gravel, or other material, as directed by the Engineer, and thoroughly rammed or rolled (when such extra fill exceeds 5 cubic yards payment will be made for the excess).

In excavating, care shall be taken not to disturb the sub-foundation, except where necessary to remove the soft or spongy material.

The entire sub-foundation shall be compact and hard, and the Contractor will be required to ram or roll it thoroughly with a roller satisfactory to the Engineer.

CONCRETE BASE.

8. After the sub-foundation has been prepared to the satisfaction of the Engineer, a concrete foundation six (6) inches thick shall be laid thereon. The concrete shall conform with the standard specifications for concrete for paving foundations, as determined by this association.

The grading and sub-foundation shall be completed at least fifty (50) feet in advance of the laying of concrete.

CUSHION COURSE.

9. On the concrete base shall be spread a layer, averaging one (1) inch in depth, of clean, coarse, dry sand, free from

all gravel exceeding one-quarter (¼)inch in size. Upon this sand bed the blocks shall be laid in courses at right angles to the line of the street, and in a straight line from curb to curb, except in special cases, when they shall be laid at such an angle as may be directed by the Engineer. The blocks shall be laid as closely as possible, each block touching the adjoining one on sides and ends, and in courses of uniform width. All joints shall be broken with a lap of at least three (3) inches. The blocks shall not be laid more than twenty-five (25) feet in advance of the ramming.

Filling Joints.

10. Depending upon the kind of filler to be used in the joints, the following specifications A, B. or C, shall govern the use of—Gas Tar Pitch (A)—Asphalt (B)—or cement Grout (C).

A.—Gas Tar Pitch Filler.

11. Immediately after the blocks are laid, sufficient coarse, hot gravel shall be spread over the surface, and swept into the joints, to fill the space between the blocks to a depth of about two (2) inches from the bottom. The blocks shall then be rammed, to settle and compact thoroughly the first layer of gravel in the joints, and so as to leave no blocks above or below the general surface of the finished pavement. The joints shall then be poured one-half full with gas tar pitch filler, as hereinafter described, and then filled to within one-half (½) inch of the surface with hot gravel, and again poured with the filler. This last pouring shall be flush with the surface of the blocks at the joints. This final pouring of the filler shall be immediately followed with a sufficient amount of hot gravel applied at the joints to cover the filler. The gravel shall be clean, washed gravel, between one-eighth (⅛) and three-eighths (⅜) inch in its largest dimension, not over twenty-five (25) per cent. of which shall be of the three-eighths (⅜) inch size. The filler shall also comply with the following test requirements:

1. It shall have a specific gravity between 1.23 and 1.33 at 60 degrees Fahr.

2. It shall have a melting point between 110 and 125 degrees Fahr., determined by the cube method in water.

3. It shall contain not less than twenty (20) per cent., nor more than thirty-five (35) per cent. of free carbon insoluble in hot benzol or chloroform.

4. It shall contain not more than one-half (½) per cent. of inorganic matter.

5. It shall be free from water.

6. It shall have a ductility of not less than sixty (60) centimeters at 77 degrees Fahr.

The gas tar pitch filler shall be used on the work at a temperature of not less than two hundred and fifty (250) degrees Fahr. and shall at no time be heated above three hundred and twenty-five (325) degrees Fahr.

In applying the gravel and filler care shall be taken that the pavers are closely followed by the filler gang, and in no case shall the paving be left over night (or when work is stopped) without the filler being completed. In case of rain stopping the filler gang before its work is finished, the joints shall be protected by the use of tarpaulins, or other means to keep out water, and under no circumstances shall the filler be poured into wet joints.

B—Asphalt Filler.

12. Immediately after the blocks are laid, sufficient coarse hot gravel shall be spread over the surface and swept into the joints so as to fill the space between the blocks to a depth of about two (2) inches from the bottom.

The blocks shall then be rammed to settle and compact thoroughly the first layer of gravel in the joints, and so as to leave no blocks above or below the general surface of the finished pavement.

The joints shall then be poured one-half full with an asphalt filler as hereinafter described, and then filled to within one-

half (½) inch of the surface with hot gravel and again poured with the filler. This last pouring shall be flush with the surface of the blocks at the joints. This final pouring of the filler shall be immediately followed with a sufficient amount of hot gravel applied at the joints to cover the filler.

The gravel shall be clean, washed gravel between one-eighth (⅛) and three-eighths (⅜) inch in its largest dimension, not over twenty-five (25) per cent. of which shall be of three-eighths (⅜) inch size.

13. The filler shall be an asphaltic cement, entirely free from coal tar or any product of coal tar distillation.

It shall be waterproof, free from water or decomposition products, shall adhere firmly to the paving stones, and shall remain ductile and pliable at all climatic temperatures to which it may be subjected in actual use, and shall not run in the joints in the hottest temperature of summer, nor become hard or brittle through the action of frost.

The asphalt filler shall conform with the following requirements:

(a) It shall contain not less than 99 per cent. of pure bitumen soluble in carbon bisulphide.

(b) Of the total bitumen soluble in carbon bisulphide, not less than 98½ per cent. shall be soluble in carbon tetrachloride.

(c) It shall have a penetration of not less than 13 at 32 degrees Fahr., when tested with a No. 2 needle under a load of 200 grams for 1 minute.

(d) It shall have a penetration of not more than 250 at 115 degrees Fahr., when tested with a No. 2 needle under a load of 50 grams for 5 seconds.

(e) It shall have a penetration of not less than 40 nor more than 60 at 77 degrees Fahr., when tested with a No. 2 needle under a weight of 100 grams for 5 seconds.

(f) It shall have a ductility of not less than 7 centimeters at 77 degrees Fahr., the rate of elongation being 5 centimeters per minute.

The paving cement shall be heated on the work to a temperature of not less than three hundred and seventy-five (375) degrees Fahr., nor more than four hundred and twenty-five (425) degrees Fahr., in such quantities as will allow of this temperature being maintained in the kettle during progress of the pouring, and no cement, the temperature of which is less than three hundred and seventy-five (375) degrees Fahr., shall be used.

It shall then be put into a conical can and poured into the joints as hereinbefore described.

It shall be delivered on the work at least one week before being used and in sufficient quantities to allow of suitable samples for examination and analysis, and such samples shall conform with the above requirements.

14. All the joints between the stones shall be filled with this hot paving cement, continuing the pouring until the joints are entirely filled, but no flushing of the pavement will be permitted.

In applying the gravel and filler, care shall be taken that the pavers are closely followed by the filler gang, and in no case shall the paving be left over night (or when work is stopped) without the filler being completed. In case of rain stopping the filler gang before its work is finished, the joints shall be protected by tarpaulins or other means, so as to keep out water, and under no circumstances shall the filler be poured into wet joints.

C—Cement Grout Filler.

15. Immediately after the blocks are laid, sufficient gravel shall be spread over the surface and swept into the joints so as to fill the space between the blocks to a depth of about two (2) inches from the bottom.

The blocks shall then be rammed to settle and compact thoroughly this layer of gravel in the joints and so as to leave no blocks above or below the general surface of the finished pavement.

16. After the pavement has been brought to a uniform surface, Portland cement grout shall be poured into the joints until it appears on the surface. The grout shall be broomed into the joints, if necessary to fill the same, and the operation shall be continued as the grout settles, until the joints are thoroughly filled flush with the surface of the blocks, immediately after which the entire pavement shall be broomed to a smooth surface, sufficient grout being applied to bring said surface even with the highest part of any of the blocks. The blocks shall be wetted by sprinkling immediately before applying the grout, if the condition of the atmosphere requires this precaution to be taken.

The cement grout shall be composed of one (1) part of the best quality of freshly burned Portland cement to one (1) part of clean sharp sand. The cement and sand shall be mixed dry until the mass is thoroughly blended and of one color, to which shall be added sufficient clean, fresh water to give a proper consistency. Care shall be taken to avoid using an excess amount of water.

The grout shall be mixed for this purpose, either in a machine mixer, to be approved by the Engineer, or in a box about 4 feet 8 inches long, 30 inches wide and 14 inches deep, resting on legs of different lengths, so that the mixture will readily flow to one corner of the box, the bottom of which shall be about 3 inches above the pavement. Particular attention is called to the importance of ascertaining the proportional amount of water to be used with the mixture of different kinds of cement and sand to give the best results, and when the most advantageous proportions have been ascertained, these shall be used. The mixture shall be removed from this box to the street surface with scoop shovels, all the while being stirred in the box as the same is being emptied. One such box shall be provided for about each ten feet in width of the roadway. The work of filling shall be carried forward until an advance of fifteen or twenty yards has been laid, when the same force and appliances shall be used to regrout the same

space in a like manner except that the proportions of the mixture for this second application shall be two (2) parts of Portland cement to one (1) part sand. The work shall be kept lightly sprinkled with water on the surface ahead of the sweepers by means of a sprinkling can, or other suitable device, to avoid a possibility of causing the grouting to become too thick at any point. To insure the penetration of the grout into the joints of the pavement there shall be used, in addition to the brooms, a squeegee scraper fifteen to eighteen inches in length on the last application of the grout.

Within one-half to three-quarters of an hour after the last coat has been applied and the grout between the joints has fully subsided and the initial set is taking place, the whole surface shall be lightly sprinkled with water and the surplus mixture left on the top shall be swept into the joints, bringing them up flush and full. After the grouting is done and a sufficient time for hardening has elapsed, so that a coating of sand will not absorb any moisture from the cement mixture, one-half ($\frac{1}{2}$) inch of sand shall be spread over the whole surface, in case the work is subjected to a hot summer's sun, in which case an occasional sprinkling to dampen the sand shall be made for two or three days. After the grouting is completed, the street shall be kept closed and no carting or traffic allowed until at least seven days have elapsed on any portion of the street grouted, and the face of the pavement shall be kept moist if the condition of the weather requires this precaution, as may be directed by the Engineer. Should the bond between the blocks become broken for any reason during the progress of the work the joints shall be cleaned out, even if it is necessary to take up and relay the blocks, and such part so taken up and relaid shall be regrouted and rebarricaded.

DISCUSSION.

MR. HARRIS: Why has 4-inch granite block been eliminated?

MR. TILLSON: We never had 4-inch block; it never was specified.

Mr. Harris: Is there any objection to specifying 4-inch block?

Mr. Tillson: I presume the sub-committee did not think a 4-inch block was suitable, that is, not for the traffic that granite block is usually laid for. There would be no objection to a city using napped granite for light traffic, but this is a standard specification, and the committee did not want to recommend a shallower block. This block is usually laid on heavy traffic streets and should have a greater depth.

Mr. Sherrerd: Also, it is unwise to use the 4-inch, because the blocks are usually made with one side or edge better than the other for a surface, and where you make them 4-inch, the pavers are likely to lay them so that they do not lie with the head up, but will lay the blocks across the grain.

Mr. Howard: This is not a specification covering recut granite block?

Mr. Tillson: No. There is a special provision as to that.

Mr. Folwell: Does the committee think this would cover any of the small sized block?

Mr. Tillson: No; it would not cover them at all. The size would shut them out. It would be an entirely different specification.

REPORT OF SUB-COMMITTEE ON SPECIFICATIONS FOR BRICK PAVING.

The report of the Sub-Committee on Brick Paving was made verbally by its Chairman, E. H. Christ, as shown in the following transferred from the minutes of the Convention:

MR. CHRIST: One change was to adopt a minimum abrasive loss as well as a maximum. (Reads paragraph as to that.) This means if you get a brick that stands 18, the test might be as low as 10. The idea is to fix a maximum, which is 22, but if you can get a brick at 20, it might go down to 12, but none then must go over 20 or below 12. It fixes a range within which they must go.

MR. SHERRERD: The average 10 brick the test calls for?

MR. CHRIST: Yes, of 10 medium, 10 light or 10 dark brick. If the 10 light brick run 22, the dark ones must not run below 14, a single test of 10 brick.

There is a change in the subject of cushion sand under brick pavements. This change was made because the contractor could use anything that passed ¼-inch screen. It is changed to read as follows. (Reads.) The former specification said it should not have any loam, and that the sand must be of ¼-inch screen. This is to do away with the real fine sand, which if it becomes wet, and is rolled with a roller, is apt to be forced down into the joints, and you don't get your filler in; and if you have coarser sand, and get rain on it it will drain out quicker than the fine sand used in some localities. There is one clause that should have been put in here by Mr. Cellarius, but he forgot it; in place of this sand layer could be used granite screenings, limestone screenings, slag, or anything that would meet the requirements of the sand. There are many locations where they cannot get sand.

MR. TILLSON: Do we wish that clause inserted?

MR. CHRIST: We do. There was a little section added to the laying of the brick, which reads as follows. (Reads.) Many engineers have said if you culled the brick, you couldn't use it for anything else, but we find many of these bricks can be broken in two and used for a bat, and that should be done. There is also a slight change in the rolling. Under the other specification the contractor would roll it very firmly and embed it in the sand to the top, and the change suggested is that the brick be rolled until the pavement has a smooth surface. There is a change in the manner of mixing the grout. (Reads "The sand shall be clean * * * 100 standard sieve.") We found that in mixing a sack of cement and an equal amount of sand in a wet box, it didn't get thoroughly mixed, and that you couldn't get an inspector who would stay there and watch every sack of cement mixed, and we decided to mix ahead enough to do the grouting intended at that time, but not for a long enough time that the dry mixture would spoil. We hope to get a true mixture to put in the pavement. In the matter of the grouting there was a change made as follows: (Reads "The grout shall be removed with scoop shovels * * * not more than ½ inch.) They are generally filled nearly to the top, and we felt it should be kept down a little, because we want to put in a neater mixture after that settles.

MR. HODGDON: Is there any definition of what a smooth surface would be?

MR. CHRIST: With a 10-foot straight edge, when finished it shall not have a depression of over ¼ inch.

MR. HOWARD: How about keeping the bricks 4 inches deep, 4 inches with a variation of ⅛-inch above or below?

MR. CHRIST: That is the same as before.

SPECIFICATIONS FOR BRICK PAVING.

Adopted October 8, 1914.

NOTE—These specifications will be modified from time to time to keep them fully up to date. Suggestions as to modifications or additions are solicited and should be sent to the Secretary, or to E. H. Christ, Norris Building, Grand Rapids, Mich., Chairman of the Sub-Committee on Specifications for Brick Paving, and George W. Tillson, Boro Hall, Brooklyn, N. Y., Chairman of General Committee on Standard Specifications.

PART I.—THE BRICK.

CHARACTER OF BRICK.

1. All brick must be ~~strictly No. 1 pavers~~ of the sizes commercially known as "~~vitrified block," and~~ "brick," the widths of which must not vary more than one-eight (⅛) of an inch. They must be thoroughly annealed, tough and durable, regular in size, shape and evenly burned. paving

When broken, the brick shall show a dense, stone-like body, free from lime, air-pockets, cracks or marked laminations. They must not be fire flashed, smoked or treated in any manner tending to give artificially a uniform color outside. Kiln marks must not exceed three-sixteenths (3-16) of an inch, and one edge at least shall show but slight kiln marks. All brick so distorted in burning as to lay unevenly in the pavement shall be rejected.

The standard size of brick shall be ~~two and one-half (2½) inches in width, four (4) inches in depth and~~ eight and one-half (8½) inches in length~~; and the standard size of block~~ three and one-half (3½) inches in width, four (4) inches in depth, and eight and one-half (8½) inches in length. They shall not vary from these dimensions to exceed one-eighth of an inch in width and depth, and not more than one-half (½)

inch in length. If the edges of the brick are rounded, the radius shall not exceed three sixteenths (3-16) of an inch. Only brick with raised lugs on one side not to exceed one-fourth (¼) inch in height shall be used.

not less than 1/8 inch

Inspection.

2. All brick shall be subject to thorough inspection before and after laying and rolling, and all rejected material shall be immediately removed from the street.

Factory inspection of brick including the rattler test shall be made if in the judgment of the Engineer it be expedient. This test shall, however, in no wise prevent further tests of the brick after they have been received upon the improvement, if in the judgmeent of the Engineer such is warranted.

Delivery Of Brick.

The brick shall be hauled, carefully unloaded by hand, and neatly piled on the walks or outside of the curbs before the grading is finished, and in laying be carried from there to the pavement.

Rattler Test For Block Size.

4. The brick shall not lose of their weight more than 22 per cent. after being submitted to the following tests, provided, however, that brick from any one factory and used in any one improvement shall not vary more than eight (8) points.

Samples of brick of uniform shape and appearance shall be taken from each car tested (estimated at 10,000 brick). Brick having a defect that would cull them shall not be used. Three grades of samples shall be tested, one of the softest, one of the medium and one of the hardest burned. If all of the tests overrun the above percentage of loss, the car shall be rejected. If one or two of the tests overrun, another test of said grade or grades shall be made. Should only one of these tests overrun the specified percentages of loss, the con-

tractor may cull said grade, provided they do not exceed ten (10) per cent. of the amount of brick in the car, and deliver the balance on the improvement. Otherwise the whole car will be rejected.

In order to prevent the continued shipments of inferior brick, only two cars of two separate shipments of any make of brick will be tested. Should they fail to meet the requirements stated above said make of brick will be rejected for this improvement.

Number And Condition Of Brick.

5. Ten (10) paving brick shall constitute the number to be used in a single test. The brick shall be thoroughly dried for at least three (3) hours in a temperature of one hundred (100) degrees Fahrenheit before testing.

Tests Before Unloading.

6. The contractor shall notify the proper city official of the location and car number of each carload of brick received, so that samples, if deemed necessary, may be taken and tested by the city, and no brick shall be delivered on or adjacent to any improvement on which brick are to be used until a written statement has been received from the Engineer or his authorized representative, that they have been superficially inspected or have passed the required tests. Decision relative to each carload will be made within twenty-four (24) hours of notice. Permission to deliver brick on the line of work shall not be considered a final acceptance in any respect.

Making The Rattler Test.

7. *The Rattler.*—The machine shall be of good mechanical construction, self-contained, and shall conform to the following details of material and dimensions, and shall consist of barrel, frame and driving mechanism as herein described.

The Barrel—The barrel of the machine shall be made up of the heads, headliners and staves.

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The heads shall be cast with trunions in one piece. The trunion bearings shall not be less than two and one-half (2½) inches in diameter or less than six (6) inches in length.

The heads shall not be less than three-fourths (¾) inch thick nor more than seven-eighths (⅞) inch. In outline they shall be a regular fourteen (14) sided polygon inscribed in a circle twenty-eight and three-eighths (28⅜) inches in diameter. The heads shall be provided with flanges not less than three-fourths (¾) inch thick and extending outward two and one-half (2½) inches from the inside face of head to afford a means of fastening the staves. The flanges shall be slotted on the outer edge, so as to provide for two (2) three-fourths (¾) inch bolts at each end of each stave, said slots to be thirteen-sixteenths (13-16) inch wide and two and three-fourths (2¾) inches center to center. Under each section of the flanges there shall be a brace three-eighths (⅜) inch thick and extending down the outside of the head not less than two (2) inches. Each slot shall be provided with recess for bolt head, which shall act to prevent the turning of the same. There shall be for each head a cast iron headliner one (1) inch in thickness and conforming to the outline of the head, but inscribed in a circle twenty-eight and one-eighth (28⅛) inches in diameter. This liner or wear plate shall be fastened to the head by seven (7) five-eighths (⅝) inch cap screws, through the head from the outside. These wear plates, whenever they become worn down one-half (½) inch below their initial surface level, at any point of their surface, must be replaced with new. The metal of which these wear plates are to be composed shall be what is know as hard machinery iron and must contain not less than one(1) per cent. of combined carbon. The faces of the polygon must be smooth and give uniform bearing for the staves. To secure the desired uniform bearing the faces of the head may be ground or machined.

The Staves—The staves shall be made of six (6) inch medium steel structural channels twenty-seven and one-fourth

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(27¼) inches long and weighing fifteen and five-tenths (15.5) pounds per lineal foot.

The channels shall be drilled with holes thirteen-sixteenths (13-16) inch in diameter, two (2) in each end, for bolts to fasten same to head, the center line of the holes being one (1) inch from either end and one and three-eighths (1⅜) inches either way from the longitudinal center line.

The spaces between the staves will be determined by the accuracy of the heads, but not exceed five-sixteenths (5-16) inch. The interior or flat side of each channel must be protected by a lining or wear plate three-eighths (⅜) inch thick by five and one-half (5½) inches wide by nineteen and three-fourths (19¾) inches long. The wear plate shall consist of medium steel plate and shall be riveted to the channel by three (3) one-half (½) inch rivets, one of which shall be on the center line both ways and the other two on the longitudinal center line and spaced seven (7) inches from the center each way. The rivet holes shall be counter-sunk on the face of the wear plate and the rivets shall be driven hot and chipped off flush with the surface of the wear plate. These wear plates shall be inspected from time to time and if found loose shall be at once re-riveted, but no wear plate shall be replaced by a new one except as the whole set is changed. No set of wear plates shall be used for more than one hundred and fifty (150) tests under any circumstances. The record must show the date when each set of wear plates goes into service and the number of tests made upon each set.

The staves when bolted to the heads shall form a barrel twenty (20) inches long, inside measurement, between wear plates. The wear plates of the staves must be so placed as to drop between the wear plates of the heads. These staves shall be bolted tightly to the heads by four (4) three-fourths (¾) inch bolts and each bolt shall be provided with lock nuts and shall be inspected at not less frequent intervals than every fifth (5th) test and all nuts kept tight. A record shall be made after each such inspection, showing in what condition the bolts were found.

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The Frame and Driving Mechanism—The barrel shall be mounted on a cast-iron frame of sufficient strength and rigidity to support same without undue vibration. This shall rest on a rigid foundation and be fastened to same by bolts at not less than four points.

It shall be driven by gearing whose ratio of driver to driven shall not be less than one (1) to four (4). The counter shaft upon which the driving pinion is mounted shall not be less than one and fifteen-sixteenths (1 15-16) inches in diameter, with bearings not less than six (6) inches in length and belt driven and the pulley shall not be less than eighteen (18) inches in diameter and six and one-half (6½) inches in face. A belt of six (6) inch double-strength leather, properly adjusted so as to avoid unnecessary slipping, shall be used.

THE ABRASIVE CHARGE.

8. The abrasive charge shall consist of two sizes of cast-iron spheres. The larger size shall be three and seventy-five hundredth (3.75) inches in diameter when new and shall weigh when new approximately seven and five-tenths (7.5) pounds (3.40 kilos) each. Ten shall be used.

These shall be weighed separately after each ten tests, and if the weight of any large shot falls to seven (7) pounds (3.175 kilos) it shall be discarded and a new one substituted; provided, however, that all of the large shot shall not be discarded and substituted by new ones at any single time, and that so far as possible the large shots shall compose a graduated series in various stages of wear.

The smaller size sphere shall be, when new, one and eight hundred seventy-five thousands (1.875) inches in diameter and shall weigh not to exceed ninety-five hundredths (0.95) pound (0.430 kilo) each. Of these spheres so many shall be used as will bring the collective weight of the large and small spheres most nearly to three hundred (300) pounds, provided that no small sphere shall be retained in use after it has been worn down so that it will pass a circular hole one and seventy-five

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hundredths (1.75) inches in diameter, drilled in cast iron plate one-fourth (¼) inch in thickness, or weigh less than seventy-five hundredths (0.75) pound (or 0.34 kilo.) Further the small spheres shall be tested after every ten tests, by passing them over such an iron plate drilled with such holes, or by weighing, and any which pass through or fall below the specified weight shall be replaced by new spheres; provided, further, that all of the small spheres shall not be rejected and replaced by new ones at any one time, and that so far as possible the small spheres shall compose a graduated series in various stages of wear. If at any time any sphere is found to be broken or defective it shall at once be replaced.

The iron composing these sphere shall have a chemical composition within the following limits:

	Per Cent
Combined carbon—not less than	2.50
Graphitic carbon—not more than	0.10
Silicon—not more than	1.00
Manganese—not more than	0.50
Phosphorous—not more than	0.25
Sulphur—not more than	0.08

For each new batch of spheres used the chemical analysis must be furnished by the maker, or be obtained by the user, before introduction into the charge; and unless the analysis meets the above specifications, the batch of spheres shall be rejected.

The Test.

9. The rattler shall be rotated at a rate of not less than 29½ nor more than 30½ revolutions per minute, and 1,800 revolutions shall constitute the standard test. A counting machine shall be attached to the rattler for counting the revolutions.

A margin of not to exceed ten revolutions will be allowed for stopping. In case a charge is allowed to run several minutes beyond its proper termination, and the loss incurred is still within the prescribed limits, then the test shall not be discarded, but the fact shall be entered on the record.

Stopping and Starting—Only one start and stop per test is regular and acceptable. If from accidental causes a test is stopped and started twice extra, and the loss exceeds the maximum permissible, the test shall be disqualified and another made.

THE RESULTS.

10. The loss shall be calculated in percentage of the original weight of the dried brick composing the charge. In weighing the rattled brick, any piece weighing less than one (1) pound shall be rejected.

THE RECORD.

11. *Description*—The operator shall keep an official book, in which the alternate pages are perforated for removal. The record shall be kept in duplicate, by use of a carbon paper between the first and second sheets, and when all entries are made and calculations are completed, the original record shall be removed and the carbon duplicate preserved in the book. All calculations must be made in the space left for that purpose in the record blank, and the actual figures must appear. The record must bear its serial number and be filled out completely for each test and all data as to dates of inspections, weighing of shot, and replacement of worn out parts must be carefully entered, so that the records remaining in the book constitute a continuous one. In event of further copies of a record being needed, they may be furnished on separate sheets, but in no case shall the original carbon copy be removed froom the record book.

The blank form upon which the record of all official brick tests is to be kept and reported is as follows:

REPORT OF STANDARD RATTLER TEST OF PAVING BRICK.

IDENTIFICATION DATA (Serial No.)

Name of firm furnishing sample..
Name of the firm manufacturing sample................................
Street or job which sample represents................................

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Brands or marks on the brick..
Quantity furnished..................Drying treatment................
Date received.......................Date tested.......................
Length .... Breadth..........Thickness............................

STANDARDIZATION DATA.

Number of charges tested since last inspection..........................
....
....
Weight of charge (after standardization)...............................
Condition of locknuts on staves...
Condition of scales...
Ten large spheres..
Small spheres..
Total ....
Number of charges tested since stave linings were renewed..............
Repairs (Note any repairs affecting the condition of the barrel).........

RUNNING DATA.

	Time readings hour minutes seconds	Revolution Counter Readings	Running notes, Stops, etc.
Beginning of test	....	....	....
Final reading	....	....	....

WEIGHTS AND CALCULATIONS.

Initial weight of ten bricks...
Final weight of same..
Loss of weight.........................Percentage loss.................
Note: (The calculations must appear.)
....
....
Number of broken bricks and remarks on same..............................

I certify that the foregoing test was made under the specifications of .... and is a true record.

Signature of Tester........................

Date Location of Laboratory

....
....

PART II.—CONSTRUCTION OF THE PAVEMENT.

FOUNDATION.

12. The cement used shall conform to the requirements specified in Section 21. The fine aggregate shall consist of any material of siliceous or igneous origin, free from mica in excess of five per cent., and other impurities, uniformly graded, the particles ranging in size from ¼ inch to that which will pass a No. 100 standard sieve. The coarse aggregate shall be sound gravel, broken stone or slag, having a specific gravity of not less than 2.6. It shall be free from all foreign matter, uniformly graded, and shall range in size from ¼ inch up, the largest particles not to exceed in any dimension one-half the thickness of the concrete in place.

In preparing the concrete, the cement and aggregate shall be measured separately and then mixed in such proportions that the resulting concrete shall contain fine aggregate amounting to one-half of the volume of the coarse aggregate; and that seven cubic feet of concrete in place will contain ninety-four pounds of cement.

The ingredients of the concrete shall be thoroughly mixed, sufficient water being added to obtain the desired consistency, and the mixing continued until the materials are uniformly distributed, and each particle of the fine aggregate is thoroughly coated with cement, and each particle of the coarse aggregate is thoroughly coated with mortar.

When a mechanical concrete mixer is used, the materials must be proportioned dry, and then deposited in the mixer all at the same time. The mixer must produce a concrete of uniform consistency and color, with the stones thoroughly mixed with the water, sand and cement.

The materials shall be mixed wet enough to produce a concrete of a consistency that will flush readily under light tamping, but which can be handled without causing a separation of the coarse aggregate from the mortar.

Re-tempering, that is, remixing with additional water, mortar or concrete that has partially hardened, will not be permitted.

The concrete shall be deposited in a layer on the sub-grade in such quantities that, after being thoroughly rammed in place, it will be of the required thickness, and the upper surface shall be true, uniform and parallel with the surface of the finished pavement.

In conveying the concrete from the place of mixing to the place of deposit, the operation must be conducted in such a manner that no mortar will be lost and the concrete must be so handled that the foundation will be of uniform composition throughout, showing no excess nor lack of mortar in any place.

The foundation shall be 6 inches in thickness, with its upper surface finished parallel to and 5½ inches below the grade of the finished pavement.

When complete, the foundation shall be kept moist for not less than 2 days and it shall be protected from traffic until the concrete has thoroughly set.

No concrete shall be mixed while the air temperature is below 32° Fahr., and in no case shall any material containing frost be used; and if this temperature is reached at any time before the foundation shall have been thoroughly set, it shall be immediately provided with such covering as will protect it from all damage.

In no event shall a concrete foundation be laid on a frozen sub-grade.

Sand Cushion.

13. Over the foundation, which must be thoroughly cleaned, shall be spread to a uniform depth of one and one-half (1½) inches (after rolling) a cushion of clean, sharp sand, free from foreign matter except that it may contain not to exceed ~~10~~ 5 per cent. of loam. The sand must be fairly well graded from one-quarter (¼) inch to that which will be retained on No. 50 standard mesh sieve. The word "sand" includes broken stone or slag meeting the specified grading.

The cushion shall be carefully shaped to a true cross-section of the roadway by means of a template having a steel faced edge, covering at least one-half (½) the width of the brick work, and so fitted with rollers as to be easily drawn on the curb and guide timbers or rail.

14. *Template*—The template shall be built in substantial accordance with plan accompanying these specifications.

15. *Guide Timbers*—Guide timbers shall be one and one-half (1½) inches by four (4) inches by sixteen (16) feet, dressed on two sides, laid to a true surface in the center of the street, and also next to the curb if the curb cannot be used.

16. *Shaping Cushion*—Before shaping the cushion a one-half (½) inch strip shall be laid on the curb, and guide timbers, or rail, and the template drawn over the same, after which the one-half (½) inch strip shall be removed, the cushion slightly moistened and rolled over its entire surface with a hand roller. The roller shall not be less than thirty-six (36) inches in diameter, twenty-four (24) inches in width, and shall weigh not less than ten (10) pounds per inch in width, and have a handle twelve (12) feet in length. After rolling, the template shall be drawn over the curb and guide timbers or rail, to complete the cushion. The cushion shall be prepared at least fifty (50) feet in advance of the brick laying.

Laying The Brick.

17. The brick shall be laid in straight lines on edge, at right angles to the curb. At intersections they shall be laid as directed. Brick shall be laid with the lug sides all in the same direction. Brick must be placed close together, both ends and sides, breaking joints at least three (3) inches. At every fourth course the brick shall be driven together to secure tight joints and straight courses, and all thick brick shall be removed. Brick shall be used with the best edge up. Broken, chipped or warped brick, not suitable to lay as a whole, may be used for batting.

When any section shall contain more than ten (10) per cent. of culls, the brick shall be taken up and the cushion adjusted. Brick shall be laid from curb to curb, or car track to curb.

No bats or broken brick shall be used except at curbs or at street car tracks. Batting for closures shall immediately follow the laying.

Joints shall be cut square with the top and sides of the brick. All joints must be kept clean and open to the bottom until filled as specified.

Street Car Tracks.

18. Along the street car tracks the brick must not be laid within one-quarter (¼) of an inch of the rail, and when rolled shall be one-quarter (¼) inch below the top of the rail.

The space between the web of the rail and the brick shall be filled with cement mortar, consisting of two (2) parts sand and one (1) part Portland cement. The mortar shall be in proper condition and the edge constructed to a straight line before the brick are laid.

Expansion Joints For Cement Grout Filler.

19. Expansion joints shall be placed parallel with and at each of the curb lines, and shall be one and one-half (1½) inches in width. The joints shall be made by placing together on edge, parallel with the crub, two wedge-shaped strips six (6) inches in width, and dressed on two faces. The strip next to the curb shall be one (1) inch wide on top, beveled to a thickness of one-half (½) inch at the bottom, and the strip next to the brick shall be of the same dimensions and placed in a reverse position. The brick shall be laid lightly against said strips. Soon after the pavement has been grouted and the cement filler has set, and the pavement is in all other respects finished, the strips shall be removed, the joints thoroughly cleaned out, and immediately completely filled with

a bituminous filler composed of a material which, when penetrated by a No. 2 needle under a weight of 200 grams for one (1) minute at a temperature of 32° Fahr., will have a penetration of not less than 20, and when penetrated by a No. 2 needle under 50 grams for five (5) seconds in a temperature of 115° Fahr., will not have a penetration of over 100.

A premolded expansion strip made of a material unaffected by the action of water or street liquids may be used along each curb line, if it meets all the requirements for the joint filler herein specified. These strips shall not be less than three-quarters (¾) of an inch in width for a thirty (30) foot street or under, increasing proportionately in width to one and one-half (1½) inches in width for a fifty (50) foot street or over.

Rolling.

20. After the brick in the pavement have been passed for rolling and the surface swept clean, the pavement shall be rolled with a roller weighing not less than three (3) nor more than five (5) tons, in the following manner: The brick next the curb shall be tamped with a hard wood tamper, to the proper grade. The rolling shall then commence near the curb at a very slow pace, and continue back and forth toward the center, until the center of the street is reached; then, passing to the opposite curb, it shall be repeated in the same manner to the center of the street. After this first passing of the roller the pace may be quickened and the rolling continued until the brick pavement has a smooth surface. The pavement shall then be rolled transversely at an angle of forty-five (45) degrees from curb to curb, repeating the rolling in the opposite forty-five (45) degree direction. Before and after this transverse rolling has taken place, all broken or injured brick must be taken up and replaced with perfect ones. The substitute brick must be brought to the true surface by tamping.

After final rolling the pavement shall be tested with a ten (10) foot straight edge, laid parallel with the curb, and any depression exceeding one-quarter (¼) of an inch must be taken out. If necessary, the pavement shall be again rolled.

Portland Cement Grout Filler.

21a. The filler shall be composed of one part each of fine, clean, sharp sand and Portland cement.

The cement shall meet the requirements of the standard specifications for Portland cement of the American Society for Testing Materials, adopted August 16, 1909, with subsequent amendments.

The sand shall be clean and sharp, fairly well graded from that passing a 20 standard sieve to that retained on a 100 standard sieve. Sand shall be measured in a box having the same cubical contents as one sack of cement.

Before any grouting is done, a sufficient amount of cement and an equal amount of sand to complete the work prepared for grouting at that time, but not to exceed ~~one-half (½) day's~~ 2 [illegible] run shall be thoroughly mixed dry until the mass assumes a uniform color. From this mixture an amount not exceeding two (2) cubic feet shall be taken and placed in the grouting box and enough clean water added to obtain a grout that will penetrate to the bottom of the brick. From the time the water is applied until all is removed and floated into the joints of the pavement, the mixture must be kept in constant motion. A mechanical mixer approved by the Engineer that will meet these requirements may be used after the dry mixture of sand and cement has been made. Before the grout is applied the brick shall be thoroughly wet by being gently sprayed.

The water shall be added to this dry mixture in a box preferably about four (4) feet, eight (8) inches long, thirty (30) inches wide, and fourteen (14) inches deep, resting on legs of different lengths, so that the mixture will rapidly flow to the lower corner of the box, the bottom of which shall be about three (3) inches above the pavement. One box shall

be used for each fourteen (14) feet in width of roadway, and at least two (2) boxes must be used in all cases.

The grout shall be removed from the box with scoop shovels and applied to the brick in front of the sweepers, who shall rapidly sweep it lengthwise of the brick into the unfilled joints, until the joints are filled to within not more than one-half (½) inch of the top of the brick. After the grout has had a chance to settle into the joint and before the initial set develops, the balance of every joint shall be filled with a thicker grout, and, if necessary, refilled, until the joints remain full to the top.

After this application has had time to settle and before the initial set takes place, the pavement shall be finished to a smooth surface with a squeegee or wooden scraper having a rubber edge, which shall be worked over the brick at an angle with the brick.

When completed and the cement has received its initial set, the pavement shall be covered with a one-half (½) inch layer of sand, which shall be frequently sprinkled in warm weather. No travel shall be permitted on the pavement for a period of at least seven (7) days after grouting, or longer, as the Engineer may require on account of weather conditions.

Ample barricades and watchmen shall be provided by the contractor for the proper protection to the grouting.

Coal Tar Paving Pitch Filler.

21b. The joints or spaces between the bricks, and those between the bricks and the curb, railroad tracks, around manholes, etc., shall be filled with coal tar paving pitch, which shall comply with the following requirements:

Physical Properties—When in place in the pavement, it shall be of such character that it will adhere firmly to the paving brick and to the curb, and shall be sufficiently plastic to allow for the contraction and expansion in the pavement without developing cracks in the joints. The filler shall be such that

it retain its consistency under extreme temperature. It shall be proof against action by water and all acids and alkalis to which the pavement may be exposed.

The free carbon shall not be less than 25 per cent. nor more than 40 per cent. The specific gravity shall not be less than 1.23 nor more than 1.30 at 60° Fahr.

Melting Point—It shall have a melting point varying not more than 5 degrees from 135° Fahr., determined by the cube method (hereinafter described).

Methods of Use—The filler shall be heated and poured into the joints to the full depth thereof, at a temperature of not less than 300° Fahr., nor greater than 350° Fahr. All joints shall be completely filled at the top. The top dressing of sand shall be spread over the pavement immediately after the filler is applied and while it is still soft. In cold weather the sand shall be heated so as to readily bond with the pitch. Extra care shall be used at the gutters and around catch basins, etc., to effectually prevent the leakage of water into the sub-roadway.

Test For Melting Point of Pitch Filler—A clean shaped one-half inch cube of the pitch is to be formed in the mold and suspended in the beaker so that the bottom of the pitch to be tested is one (1) inch above the bottom of the beaker. The pitch is to remain for five (5) minutes in water of a temperature of 60° Fahr. before heat is applied. Heat is to be applied in such a manner that the temperature of the water is raised 9° Fahr. each minute. The temperature recorded by the thermometer at the instant the pitch touches the bottom of the beaker to be considered the melting point.

Asphalt Filler.

21c. The interstices of the brick shall be completely filled with an asphalt filler heated to a temperature of not less than 350° Fahr. nor more than 450° Fahr. This asphalt filler shall not contain pitch nor any part of coal tar. It shall contain at least ninety-eight (98) per cent. of bitumen soluble in carbon bisulphide. It shall remain pliable at all temperatures to which it may be subjected as a street paving filler; it shall

be absolutely proof against water and street liquids; it shall firmly adhere to the brick and be pliable rather than rigid. Care shall be exercised to completely fill all openings around street structures and the street shall not be used for traffic until the filler is completely set. A top dressing of sand shall be spread immediately after the filler is applied and while it is still soft.

The penetration shall conform to the following:

No. 2 needle, 5 sec., 100 grams at 77° F., 25 to 60.
No. 2 needle, 1 min., 200 grams at 32° F., not below 25.
No. 2 needle, 5 sec., 20 grams at 115° F., not above 110.

MAINTENANCE.

22. The period of guaranty shall be five (5) years. During the period of guaranty, whenever the surface of a vitrified brick pavement becomes uneven, holding water one-fourth (¼) of an inch or more in depth in a distance of four feet or less, or when the pavement has settled over trenches existing previous to the completion of the pavement, then the brick shall be taken up and relaid to proper crown and grade.

Any brick which may be found soft, unsound, broken or disintegrated, and all portions of the pavement which may have become rough by reason of the chipping or breaking of the edges of the brick, so as to produce joints exceeding one-half (½) inch at a point one-quarter (¼) inch below the surface of the brick, shall be removed, and properly replaced with sound material.

NOTE—All castings for manholes, catchbasins, etc., shall not be imbedded in the concrete foundation. They shall be made to rest on top of the foundation to allow the pavement to expand uniformly, thereby avoiding the cracking and crushing of the brick.

NOTE TO ENGINEER—Section 1. ~~Whenever the word "brick"~~ is used in the specification it is intended to refer to ~~either~~ brick or block, ~~whichever~~ may be used, except in Section 4.

Section 4. Where medium or light traffic or other conditions exist which, in the opinion of the Engineer, do not require a brick capable of giving an abrasive loss of only 22 per cent., brick of a quality which will give a loss of 25 per cent. or even 28 per cent. may be used.

Inasmuch as the committee has not made any tests of the brick size, it is not prepared to recommend specific abrasion loss for that size.

Section 21. While the committee is in favor of a cement grout filler, it believes that where conditions do not favor the use of the same, a bituminous filler may be used, for which it recommends Section 21b or 21c in place of 21a.

recommends

REPORT OF SUB-COMMITTEE ON SPECIFICATIONS FOR CONCRETE PAVING.

The Sub-Committee on Concrete Paving Specifications presents, for your consideration, the following report:

In preparing these specifications we have tried to co-ordinate the last specification of the American Society of Municipal Improvements (1912) with those of the Association for Standardizing Paving Specifications (1913) together with the discussions and suggestions offered.

We have omitted the paragraph (P. 228, 1912) requiring that the mortar made with one part cement and three fine aggregate have a tensile strength of 70 per cent. of that obtained by making a mortar of the same cement and proportion of Ottawa sand, because some engineers prefer a different definition, such as: a test requirement of tensile strength of say 100 pounds per square inch when tested at the end of 48 hours in air under standard conditions. It is hoped this subject may be discussed in order that the opinion of the convention may be obtained. Either one of the provisions should be inserted in the specifications as presented as part of the paragraph "Fine Aggregate."

It appears to your committee that the Brick Specification is the only one in the 1912 report which defines concrete as a foundation for paving, and suggests that a reference be made to it as a type in other specifications or that the subject be referred to your next Concrete Committee for their consideration, with the idea of bringing all the concrete work for pavement together.

C. E. P. Babcock, *Chairman,*
H. L. Shaner,
H. G. Lykken,
N. E. Murray,
J. H. Weinberger,
Fred Burkhard,
Committee.

SPECIFICATIONS FOR CEMENT CONCRETE PAVING.

Adopted October 8, 1914.

NOTE—These specifications will be modified from time to time to keep them fully up to date. Suggestions as to modifications or additions are solicited and should be sent to the Secretary, or to C. E. P. Babcock, City Hall, Buffalo, N. Y., Chairman of the Sub-Committee on Specifications for Concrete Paving, and George W. Tillson, Boro Hall, Brooklyn, N. Y., Chairman of General Committee on Standard Specifications.

GENERAL REQUIREMENTS.

CONCRETE.

1. The concrete to be used shall consist of Portland cement, fine aggregate or sand, coarse aggregate and water, mixed in the required proportions.

CEMENT.

2. Portland cement shall meet the requirements of the standard specifications for Portland cement, adopted by the American Society for Testing Materials, August 16, 1909, with subsequent amendments.

All tests to be made in accordance with methods contained in report of Committee on Uniform Tests of Cement of the American Society of Civil Engineers, presented at the Annual Meeting, January 18, 1911, with subsequent amendments. (See Fourth Annual Report, A. S. P. S., 1913, Pittsburg meeting.)

FINE AGGREGATE.

3. The fine aggregate shall consist of any material of siliceous granitic or igneous origin, free from mica in excess of five per cent. and shall not contain in any one (1) cubic inch taken from the pile, more than seven (7) per cent. of clay, silt, vegetable or other harmful impurities.

Coarse Aggregate.

4. Coarse aggregate shall be clean sound gravel—washed if need be, to remove film or coating of clay or dirt—or broken stone or crushed slag, having a specific gravity of not less than 2.6. It shall be free from all dirt, vegetable matter and other foreign substances, graded in sizes, the largest size being not greater than will pass a two and one-half (2½) inch screen and ranging down to that which will be retained on a one-quarter (¼) inch screen.

Water.

5. The water in mixing concrete shall be clean, free from acid, alkalies and other injurious matter.

Mixing.

6. The dry ingredients (cement and other aggregate) of the concrete shall be thoroughly mixed, then sufficient water shall be added to obtain the desired consistency, and the mixing continued until all the ingredients are uniformly distributed in the mass.

If a mechanical mixer is used, the dry materials shall be proportioned and then, all at the same time, deposited in the mixer, the water shall then be added and the mixing continued as above.

Consistency.

7. The resulting concrete shall be of such consistency that the water will flush to the surface under heavy tamping.

Re-Tempering.

8. Re-tempering—that is re-mixing with additional water after the mortar or concrete has partially hardened will not be permitted.

Sub-Grade.

9. In a sand or naturally drained soil, the sub-grade shall be wet down before concrete is deposited.

Placing Concrete.

10. The concrete shall be deposited in a layer on the subgrade in such quantities that, after being thoroughly tamped in place, it will be of the required thickness, and the upper surface shall be true, uniform and parallel with the surface of the finished work.

In conveying the concrete from the place of mixing to the place of deposit, the operation must be conducted in such a manner that no mortar will be lost, and the concrete must be so handled that it will be of uniform composition throughout.

Protection.

11. After deposited, the concrete shall be kept moist and protected from traffic and elements for at least four (4) days for sidewalks and ten (10) days for pavements.

Freezing Temperature.

12. No concrete shall be mixed while the air temperature is below thirty-two (32) degrees Fahr., and in no case shall any materials containing frost be used.

In no event shall concrete be laid on a frozen foundation.

Forms.

13. Forms shall be smooth, free from warp, of sufficient strength to resist springing out of shape, and of depth to conform to the thickness of the proposed work.

All mortar and dirt shall be removed from forms that have been previously used.

The forms shall be well staked and thoroughly braced, and set to the established lines, their upper edges conforming to the grade of the finished work.

CONCRETE SIDEWALKS.

Observing the General Requirements as above: the specifications for sidewalks shall be as follows:

Drainage.

14. The sub-base or that portion of the base under the concrete shall be properly drained.

Fine Aggregate.

15. The fine aggregate shall be of graded sizes ranging from 1/4 inch down to that which shall be retained on a No. 80 standard sieve, not more than twenty (20) per cent. of which will pass a No. 50 standard sieve for the base; and from one-quarter (1/4) inch down to that which will be retained on a No. 80 standard sieve, not more than twenty (20) per cent. of which shall pass a No. 50 standard sieve for the top or wearing surface.

Coarse Aggregate.

16. The coarse aggregate shall be graded in sizes that will pass a one (1) inch screen and be retained on a quarter (1/4) inch screen.

Base Proportions.

17. In preparing the concrete for the base, the cement and aggregate shall be measured separately, and then mixed in such proportion that the resulting concrete shall contain fine aggregate to the amount of one-half (1/2) of the volume of the coarse aggregate; and that five and one-half cubic feet of concrete in place shall contain ninety-four (94) pounds of cement.

Thickness.

18. The base shall be ... inches in thickness, with its upper surface finished parallel to and ... inch below the grade of the finished sidewalk. The minimum thickness for base shall be three inches.

Sections.

19. The base shall be blocked out in sections, which should not measure more than six feet wide and six feet long.

SLOPE.

20. The walk shall have sufficient fall from lot line to curb line to provide drainage, but the slope should not exceed ⅜-inch per foot.

TOP OR WEARING SURFACE.

21. The top or wearing surface shall be composed of one part Portland cement and two parts fine aggregate, mixed with sufficient water to produce a mortar of a consistency which will not require tamping and which can be easily spread into position with a straight edge.

The mortar for the wearing surface shall be mixed in a mortar box and spread on the base immediately after mixing. In no case shall more than thirty minutes elapse between the laying of the concrete for the base and the covering of same with the wearing surface.

After the wearing surface has been worked to an approximately true plane, the slab marking shall be made directly over the joint in the base. Such marking shall be made with a tool which will cut entirely through and completely separate the surface of adjacent slabs.

The wearing surface shall be ... inch in thickness. However, the minimum thickness for wearing surface shall be three-fourths (¾) inch.

EDGES.

22. The slabs shall be rounded on all surface edges to a radius of about one-half inch.

TROWELING.

23. After the wearing surface has been brought to the established grade, it shall be worked with a wood float in a manner that will thoroughly compact it. When required, the surface shall be troweled smooth, but excessive working with a steel trowel shall be avoided. The application of neat cement to the surface in order to hasten hardening is prohibited.

One Course Sidewalk.

24. If the specifications require that the concrete walk be laid in one course, the concrete shall be mixed in such proportions that it shall contain fine aggregate to the amount of one-half (½) of the volume of the coarse aggregate and that four and one-half (4½) cubic feet of concrete in place shall contain ninety-four (94) pounds of cement.

The coarse aggregate shall be graded from fine to coarse and shall all pass the one and one-fourth (1¼) inch mesh screen and be retained on a one-fourth (¼) inch mesh screen.

The fine aggregate shall all pass the one-fourth (¼) inch mesh screen and not more than three (3) per cent. shall pass a sieve having one hundred (100) meshes per lineal inch.

The surface shall be brought to a true plane with a striking board and finished with a wooden float as heretofore provided.

CONCRETE CURB AND COMBINED CURB AND GUTTER.

Fine and Coarse Aggregate and Base Proportions, Facing or Wearing Surface, Thickness and Troweling as heretofore recommended in General Requirements and in Specifications for Concrete Walk.

Dimensions.

25. The sections for combined curb and gutter shall not measure more than six (6) feet in length nor less than four (4) feet when unprotected, and not more than ten (10) feet nor less than six (6) feet in length when protected by metal nosing.

Curb Not Built in Place.

26. When built at a point removed from the work, it shall be constructed in the same manner and of the same material as above specified, and shall be allowed to harden for at least twenty-eight (28) days before being transported for position in the work.

The length of any section shall not be less than four (4) feet nor more than six (6) feet.

CONCRETE ROADWAY.

Observing General Requirements as above; the specifications for Concrete Roadway shall be as follows:

Fine Aggregate.

27. The fine aggregate shall be of graded sizes ranging from ¼-inch down to that which shall be retained on a No. 80 standard sieve, not more than 20 per cent. of which will pass a No. 50 standard sieve.

Coarse Aggregate.

28. In concrete roadway, the largest size shall not exceed such as will pass a two and one-half (2½) inch screen, and ranging down to that which will be retained on a one-fourth (¼) inch screen.

Two Course Pavement.

29. The cement and aggregate shall be mixed in such proportions that the resulting concrete shall contain fine aggregate amounting to one-half the volume of the coarse aggregate, and so that five (5) cubic feet of concrete in place shall contain ninety-four (94) pounds of cement.

The thickness of the base shall be ... inches. (The minimum thickness shall be five (5) inches.)

Wearing Surface.

30. The top coat or wearing surface shall be composed of one part Portland cement and two parts of fine aggregate mixed with water in sufficient quantities to produce a mortar of such consistency that it will not require tamping, and can easily be spread into position with a templet or straight edge. It shall then be screeded to give roughness to surface of concrete. Not more than thirty (30) minutes shall elapse between the laying of the concrete for the base and the covering of

the same with the wearing surface. The *wearing surface* shall be of a thickness of ... inches. However, the minimum thickness shall be one (1) inch.

ONE COURSE PAVEMENT.

Observing the General Requirements and Provisions for Fine and Coarse Aggregate for Concrete Roadway as above.

31. The one course shall be laid in the proportion of not less than one bag (94 pounds) of cement to every four (4) cubic feet of concrete in place. It shall have a minimum thickness of five (5) inches.

TEMPERATURE JOINTS.

32. If temperature joints are required, they shall be made from curb to curb at intervals of about thirty (30) feet. These joints may be filled with such material as may best suit local conditions, but the local specifications shall state what filler will be furnished.

DISCUSSION.

MR. BABCOCK: It might be only fair to say, before the vote is taken, that there were two minor things changed in making up the specifications which we did not think worth while to write into the formal report. In either the report of the committee of this Society or in the report from the A. S. P. S., the definition of size of stone in concrete foundation or pavement was something like this: It allowed a maximum size equal to one-half the thickness of the concrete. We left that definition out, and said that the maximum size of stone for this work shall be 2½ inches. There was a change in the fine aggregate for sidewalk purposes. The former requirement was that the size range from ¼-inch to that retained on 100-mesh standard sieve; that was changed to range from ¼-inch down to that which would pass an 80 sieve.

MR. MYERS: It has been my experience that stone up to 2½ inches is too hard to handle, and that we didn't get as good a job as by using a 1½-inch maximum, especially with broken stone. With gravel you can naturally handle it a little larger, but with broken stone I believe 2½ inches too large.

REPORT OF SUB-COMMITTEE ON SPECIFICATIONS FOR BROKEN STONE AND GRAVEL ROADS.

Your Sub-Committee on Specifications for Broken Stone and Gravel Roads herewith respectfully submits its report covering its work during the preceding year.

In 1913 it was decided that the scope of the sub-committee should cover specifications for the following types of roads and pavements:

Broken Stone Road.
Broken Stone Road with Bituminous Surface.
Bituminous Macadam Pavement.
Gravel Road.
Gravel Road with Bituminous Surface.
Bituminous Gravel Pavement.

In view of the large amount of work entailed by the preparation of these specifications, it was decided to concentrate our attention during the past year upon specifications of the above types of construction in connection with which broken stone was employed. We are, therefore, submitting in this report specifications for Broken Stone Road, Broken Stone Road with Bituminous Surface and Bituminous Macadam Pavement, including specifications for the materials used therewith.

It has been the object of the committee to present in its specifications fundamental principles of construction. In accordance with instructions received at the Wilmington Convention in 1913, properties of broken stone and limitations covering the physical and chemical properties of bituminous materials have been incorporated in our specifications. It should be borne in mind that specifications covering the properties of materials and certain details of construction must be varied in many cases in order that a given form of construction may be economical and suitable for local conditions.

Therefore the specifications incorporated in our report should serve as *guides* rather than standards adaptable to all conditions which may be found throughout America.

As outlined by the sub-committee, the work to be considered prior to the 1915 Convention includes specifications for roads and pavements listed above in connection with which gravel is used and specifications covering methods and materials for maintaining the several types of construction assigned to the sub-committee. In accordance with instructions received under even date from the Committee on Standard Specifications, we will also prepare during the coming year specifications for a Bituminous Concrete Pavement, the mineral aggregate of which consists of one product of a crushing plant.

Respectfully submitted,

ARTHUR H. BLANCHARD, *Chairman.*
WILLIAM H. CONNELL.
A. J. LENDERINK.
R. A. MACGREGOR.
FREDERICK A. REIMER.
For the Sub-Committee on Broken Stone and Gravel Roads.

SPECIFICATIONS FOR BROKEN STONE AND GRAVEL ROADS.

Adopted October 8, 1914.

NOTE—These specifications will be modified from time to time to keep them fully up to date. Suggestions as to modifications or additions are solicited and should be sent to the Secretary, or to A. H. Blanchard, Professor of Highway Engineering, Columbia University, New York City, Chairman of the Sub-Committee on Specifications for Broken Stone and Gravel Roads, and George W. Tillson, Boro Hall, Brooklyn, N. Y., Chairman of General Committee on Standard Specifications.

1. *General Description.*—The broken stone road shall consist of three courses of broken stone, separately constructed, laid

to conform to the required grades and cross-sections and constructed as hereinafter specified.

BROKEN STONE.

2. *Quality of Broken Stone*—All broken stone shall be clean, rough surfaced and sharp angled, of compact texture and uniform grain.

Tests for Broken Stone—The broken stone shall be subjected to abrasion tests and toughness tests conducted by the Engineer in accordance with methods adopted by the American Society for Testing Materials, August 15, 1908. It shall show a "French coefficient of wear" of not less than 7.0 and its toughness shall be not less than 6.0.

3. *Sizes*—The product of the crusher shall be passed over a rotary screen with sections having respectively circular openings of the following dimensions: First section, five-eighths (5/8) inch holes; second section, one and one-quarter (1¼) inch holes; third section, two and one-quarter (2¼) inch holes; fourth section, three and one-half (3½) inch holes. If so directed the first section of the screen shall be fitted with a dust jacket having one-quarter (¼) inch openings so placed as to separate the dust from the product passing through the first section. The screening plant shall also be fitted with a tailing chute so that no stone failing to pass the largest openings will fall into the bin for No. 4 size broken stone. The various sizes of broken stone shall be caught in separate bins, and shall be designated as follows:

Dust, all passing through one-quarter (¼) inch screen.

Screenings, all passing through five-eighths (5/8) inch screen.

No. 1 size, passing through five-eighths (5/8) inch screen and over one-quarter (¼) inch screen.

No. 2 size, passing over five-eighths (5/8) inch screen and through one and one-quarter (1¼) inch screen.

No. 3 size, passing over one and one-quarter (1¼) inch screen and through two and one-quarter (2¼) inch screen.

No. 4 size, passing over two and one-quarter ($2\frac{1}{4}$) inch screen and through three and one-half ($3\frac{1}{2}$) inch screen.

Tailings, passing over three and one-half ($3\frac{1}{2}$) inch screen.

Portable Plants—Portable crushing and screening plants shall be operated as directed.

Stationary Plants—If broken stone is to be supplied from stationary crushing and screening plants, the several sizes of broken stone shall not be used unless samples have been previously approved by the Engineer. The various sizes of broken stone furnished shall be substantially the same as the samples approved.

Construction.

4. *First Course*—After the sub-grade or sub-base course shall have been prepared as specified, a course of No. 4 broken stone shall be evenly spread so that it shall have after rolling the required thickness of three and one-half ($3\frac{1}{2}$) inches. The depth of loose broken stone shall be gauged by the use of strings between iron stakes, as directed. The spreading of the broken stone must be from piles dumped on boards provided for the purpose or from piles dumped alongside the road, or as directed by the Engineer. This course shall be thoroughly rolled with a ten (10) to fifteen (15) ton road roller. The rolling shall begin at the sides of the road and continue towards the center and shall be kept up until there is no disturbance of the stone ahead of the roller. After the completion of the rolling, no teaming other than that necessary for bringing on the broken stone for the next course shall be allowed over the rolled broken stone. Should it be apparent after the rolling of the first course that the subgrade material shall have become churned up into or mixed with the broken stone of this course, whether by reason of the rolling, or by hauling over the broken stone or otherwise, the Contractor shall at his own expense remove and replace such mixture of sub-grade material and broken stone with clean broken stone of the proper size and shall roll the material to produce a uniform, firm and even first course as required.

5. *Second Course*—On the completed first course shall be spread, in the manner specified in the preceding paragraph, No. 3 broken stone to form the second course. This broken stone shall be evenly spread to such a depth that it shall have after rolling the required thickness of two and one-half (2½) inches. After the second course shall be compacted under the same provisions as prescribed for the first course, it shall be evenly covered with a thin layer of screenings. The quantity of screenings to be used shall be just sufficient to cover the larger stones and care shall be exercised to avoid the use of an excess of the screenings. This covering shall then be rolled as heretofore provided. When the rolling shall have been completed the surface of the second course shall be firm, even and true to the lines, grades and cross-sections.

6. *Third Course*—On the completed second course shall be spread in the manner above specified for the first course No. 3 broken stone to form the third course. This broken stone shall be evenly spread to such a depth that it will have after rolling the required thickness of two and one-half (2½) inches. After the third course shall have been compacted under the same provisions as prescribed for the first course, it shall be evenly covered with a thin layer of screenings. The quantity of screenings to be used shall be just sufficient to cover the larger stones and care shall be exercised to avoid the use of an excess of the screenings. This covering shall then be rolled as heretofore provided except that water shall be used in connection with the rolling as follows: after the screenings shall have been lightly rolled, water shall be sprinkled on the road surface just ahead of the roller in such quantity as will prevent the sticking to the wheels of the roller of the fine material on the surface, and the combined spreading of screenings, watering and rolling shall be continued until the voids of the broken stone become so filled with the finer particles as to result in a wave of grout being pushed along the road surface by the front wheel of the roller. When the rolling shall have been

completed the surface of the third course shall be firm, even and true to the lines, grades and cross-sections. After the third course has been compacted, puddled and filled as above specified, it shall be evenly covered with a thin layer of screenings. Should at any time, after its construction and prior to the acceptance of the road, the larger stone be visible in the surface of the road, the Contractor shall, without extra allowance, spread, sprinkle and roll sufficient screenings to completely cover the same.

Payment.

7. *Measurement and Payment*—The quantity of broken stone road to be paid for shall be the number of square yards, measured horizontally, satisfactorily completed in accordance with specifications. The price stipulated shall include the furnishing, crushing and screening of the different sizes of broken stone, the placing, rolling and watering of the broken stone, and all work and expenses incidental to the completion of the broken stone road.

SPECIFICATIONS FOR BROKEN STONE ROAD WITH BITUMINOUS SURFACE.

Broken Stone Road.

8. *General Description*—The broken stone road shall consist of three courses of broken stone, separately constructed, laid to conform to the required grades and cross-sections and constructed as hereinafter specified.

Broken Stone.

9. *Quality of Broken Stone*—All broken stone shall be clean, rough surfaced and sharp angled, of compact texture and uniform grain.

Tests For Broken Stone—The broken stone shall be subjected to abrasion tests and toughness tests conducted by the Engineer in accordance with methods adopted by the Ameri-

can Society for Testing Materials, August 15, 1908. The broken stone used for the construction of the first and second courses shall show a French coefficient of wear of not less than 7.0 and its toughness shall be not less than 6.0. The broken stone used for the construction of the third course and in connection with the bituminous surface shall show a French coefficient of wear of not less than 11.0 and its toughness shall not be less than 13.0.

10. *Sizes*—The sizes shall be in accordance with the requirements as stated in the paragraph entitled "Sizes" in the specifications for "Broken Stone Road."

CONSTRUCTION.

11. *First Course*—After the sub-grade or sub-base course shall have been prepared as specified, a course of No. 4 broken stone shall be evenly spread so that it shall have, after rolling, the required thickness of three and one-half (3½) inches. The depth of loose broken stone shall be gauged by the use of strings between iron stakes, as directed. The spreading of the broken stone must be from piles dumped on boards provided for the purpose or from piles dumped alongside the road, or as directed by the Engineer. This course shall be thoroughly rolled with a twelve (12) to fifteen (15) ton road roller. The initial rolling shall begin at the sides of the road and continue towards the center and shall be kept up until the stone is keyed together and there is no disturbance of the stone ahead of the roller. After the first course has been compacted, it shall be evenly covered with a thin layer of screenings. The quantity of screenings to be used shall be just sufficient to cover the larger stones and care shall be exercised to avoid the use of an excess of the screenings. This covering shall then be rolled as heretofore provided except that water shall be used in connection with the rolling as follows: After the screenings shall have been lightly rolled, water shall be sprinkled on the road surface just ahead of the roller in such quantity as will prevent the sticking to the wheels of the

roller of the fine material on the surface, and the combined spreading of screenings, watering and rolling shall be continued until the voids of the broken stone become so filled with the finer particles as to result in a wave of grout being pushed along the road surface by the front wheel of the roller. After the completion of the rolling, no teaming other than that necessary for bringing on the broken stone for the next course shall be allowed over the rolled broken stone. Should it be apparent after the rolling of the first course that the sub-grade material shall have become churned up into or mixed with the broken stone of this course, whether by reason of the rolling, or by hauling over the broken stone or otherwise, the Contractor shall at his own expense remove and replace such mixture of sub-grade material and broken stone with clean broken stone of the proper size and shall roll the material to produce a uniform, firm and even first course as required.

12. *Second Course*—On the completed first course shall be spread, in the manner specified in the preceding paragraph, No. 4 broken stone to form the second course. This broken stone shall be evenly spread to such a depth that it shall have, after rolling, the required thickness of three and one-half (3½) inches. The second course shall be compacted, puddled with screenings and water, and finished under the same provisions as prescribed for the first course. When the rolling shall have been completed, the surface of the second course shall be firm, even and true to the lines, grades and cross-sections. If the surface is not slightly rough, so as to afford a sufficient mechanical bond for the third course, it shall be broomed.

13. *Third Course*—On the completed second course shall be spread, in the manner above specified for the first course, No. 3 broken stone to form the third course. This broken stone shall be evenly spread to such a depth that it will have, after rolling, the required thickness of two and one-half (2½) inches. The third course shall be compacted and puddled with screenings and water under the same provisions as pre-

scribed for the second course, and when the rolling shall have been completed, the surface of the third course shall be firm, even and true to the lines, grades and cross-sections. After the third course has been compacted, puddled and filled as above specified, it shall be evenly covered with a thin layer of screenings. Should at any time, after the construction of the third course and prior to the application of bituminous material thereon, the larger stone be visible in the surface of the road, the Contractor shall, without extra allowance, spread, sprinkle and roll sufficient screenings to completely cover the same. Each section of the broken stone road shall be subjected to traffic for at least one month before the construction of the bituminous surface thereon.

Bituminous Surface.

14. *Description Bituminous Surface*—The bituminous surface shall consist of one application of refined tar covered with a layer of No. 1 broken stone constructed as hereinafter specified.

Bituminous Material.

15. *Refined Tar*—Refined tar used in the construction of the bituminous surface shall conform with either one of the specifications covering the chemical and physical properties of refined tars included under the item entitled "Refined Tars for Surface Treatments."

16. *Heating Refined Tar*—The refined tar shall be heated in kettles or tanks so designed as to admit of even heating of the entire mass, with an efficient and positive control of the heat at all times. It shall be heated as directed by the Engineer to a temperature between 93° C. (200° F.) and 121° C. (250° F.) All refined tar heated beyond 121° C. (250° F.) shall be rejected. No tar shall be heated in kettles or tanks containing any oil or asphalt cement. Before changing from one type to another, kettles or tanks shall be scrupulously cleaned in order to avoid mixtures of the two. Any mixtures of different kinds of bituminous materials shall be rejected.

Thermometers Furnished by Contractors—The Contractor shall provide a sufficient number of accurate, efficient, stationary thermometers for determining the temperature of the refined tar in kettles or tanks.

CONSTRUCTION.

17. *Preparation of Surface of Road*—Prior to the application of the refined tar, the surface of the broken stone road, when thoroughly dry, shall be swept clean of all dust, dirt or other loose material with horse or power drawn brooms and bass or other fine fibre brooms, or with stiff fibre hand brooms and bass or other fine fibre brooms, as directed by the Engineer. When the cleaning is completed the upper surface of the No. 3 broken stone shall be exposed, forming a clean mosaic surface.

18. *Application of Refined Tar*—After the surface shall have been cleaned to the satisfaction of the Engineer, and when thoroughly dry, the refined tar shall be uniformly applied over the prepared surface of the road by means of a pressure distributer as hereinafter specified and in accordance with the directions of the Engineer. The refined tar, when applied, shall have a temperature between 93° C. (200° F.) and 121° C. (250° F.). The total amount of refined tar to be used in the construction of the bituminous surface shall be applied in one application and shall not be less than one-quarter (¼) nor more than one-half (½) gallon per square yard, the precise quantity being determined by the Engineer.

Pressure Distributer The pressure distributer employed shall be so designed and operated as to distribute the refined tar specified uniformly under a pressure of not less than twenty (20) pounds nor more than seventy-five (75) pounds per square inch in the amount and between the limits of temperature specified. It shall be supplied with an accurate stationary thermometer in the tank containing the refined tar and with an accurate pressure gauge so located as to be easily observed by the Engineer while walking beside the distrib-

uter. It shall be so operated that, at the termination of each run, the refined tar will be at once shut off. It shall be so designed that the normal width of application shall be not less than six (6) feet and so that it will be possible on either side of the machine to apply widths of not more than two (2) feet. The distributor shall be provided with tires of widths dependent upon the following relationship between the pressure per square inch of tire and the diameter of the wheel; for a two (2) foot diameter wheel, five hundred (500) pounds shall be the maximum pressure per linear inch of width per wheel, an additional pressure of thirty (30) pounds per inch being allowed for each additional three (3) inches in diameter.

19. *Application of No. 1 Broken Stone*—Immediately after the application of the refined tar, a layer of dry No. 1 broken stone, not to exceed three-eighths (⅜) of an inch in thickness, shall be spread and broomed as directed by the Engineer over the surface of the refined tar and shall be at once rolled as directed by the Engineer with a roller weighing between eight (8) and fifteen (15) tons.

20. *Seasonal and Weather Limitations*—No refined tar shall be applied when the air temperature in the shade is below 10° C. (50° F.), except by the written permission of the Engineer.

PAYMENT.

21. *Measurement and Payment*—The quantity of broken stone road with bituminous surface to be paid for under this item shall be the number of square yards, measured horizontally, satisfactorily completed in accordance with the specifications. The price stipulated in this item shall include the furnishing, crushing and screening of the different sizes of broken stone, the placing, rolling and watering of the broken stone, the heating and distributing of the refined tar, and all materials, work and expenses incidental to the completion of the broken stone road with bituminous surface except the furnishing of the refined tar, which will be included for payment under the item entitled "Refined Tars for Surface Treatments."

SPECIFICATIONS FOR REFINED TARS FOR SURFACE TREATMENTS.

22. *Previous Service*—The Contractor will be required to show to the satisfaction of the Engineer, that the Company manufacturing the refined tar he proposes to use under a given specification has, for a period of at least two years, manufactured refined tar in a thoroughly equipped plant; and that refined tar manufactured of bituminous material obtained from a similar source to that which he proposes to use shall have been in continuous and successful use in the surface treatment of broken stone roads for a period of at least two years previous to the date of the letting in which his proposal was submitted.

23. *Refined Tar "A" Optional With Refined Tar "B."*

(I) Refined tar "A" shall be homogeneous, free from water and shall not foam when heated to 121° C. (250° F.)

(II) Its specific gravity at a temperature of 25° C. (77° F.) shall be not less than 1.140 nor more than 1.180.

(III) When tested by means of the New York Testing Laboratory Float Apparatus, the float shall not sink in water maintained at 50° C. (122° F.) in less than 50 seconds nor more than 110 seconds.

(IV) Its bitumen as determined by its solubility in chemically pure carbon disulphide at room temperature, shall be not less than 95.0 per cent. and it shall show not more than 0.2 per cent. ash upon ignition of the material insoluble in carbon disulphide.

(V) When distilled according to the tentative method recommended by Committee D-4 of the American Society for Testing Materials in 1911, it shall yield no distillate at a temperature lower than 170° C. (338° F.); not more than 20.0 per cent. shall distill below 270° C. (518° F.), and not more than 30.0 per cent. shall distill below 300° C. (572° F.).

(VI) The melting point as determined in water by the cube method, of the pitch residue remaining after distillation

to 300° C. (572° F.) in accordance with the test described in Clause (V) shall be not more than 75° C. (167° F.).

24. *Refined Tar "B" Optional With Refined Tar "A."*

(I) Refined tar "B" shall be homogeneous, free from water, and shall not foam when heated to 121° C. (250° F.).

(II) Its specific gravity at a temperature of 25° C. (77° F.) shall be not less than 1.170 nor more than 1.220.

(III) When tested by means of the New York Testing Laboratory Float Apparatus, the float shall not sink in water maintained at 50° C. (122° F.) in less than 40 seconds nor more than 100 seconds.

(IV) Its bitumen as determined by its solubility in chemically pure carbon disulphide at room temperature, shall be not less than 85.0 per cent. nor more than 95.0 per cent., and it shall show not more than 0.2 per cent ash upon ignition of the material insoluble in carbon disulphide.

(V) When distilled according to the tentative method recommended by Committee D-4 of the American Society for Testing Materials in 1911, it shall yield no distillate at a temperature lower than 170° C. (338° F.); not more than 20.0 per cent. shall distill below 270° C. (518° F.), and not more than 25.0 per cent. shall distill below 300° C. (572° F.).

(VI) The melting point as determined in water by the cube method, of the pitch residue remaining after distillation to 300° C. (572° F.) in accordance with the test described in Clause (V) shall be not more than 75° C. (167° F.).

25. *Delivery*—The refined tar shall be delivered in suitable containers, far enough in advance of its use in the work to permit the necessary tests to be made. Each container shall be plainly labeled with the trade name of the refined tar, name of manufacturer, gross weight and net weight. Each shipment and each carload shall be kept separate.

Bills of Lading—The Contractor shall furnish the Engineer on or before the arrival of each shipment at or near the site of the work, bills of lading, or correct copies thereof, which

shall state the trade name of the refined tar, and the name and address of the Company manufacturing and supplying it.

Samples—Samples will be taken by the Engineer from each carload of refined tar when delivered at the work, unless satisfactory arrangements can be made for sampling before shipment. Such samples shall be analyzed by the Engineer to assure the delivery of a refined tar of the specified quality and to determine, for purpose of payment, the quantity of bitumen.

26. *Work Included*—Under this item the Contractor shall furnish and deliver on the work at such points as directed refined tar which conforms with the specifications of either refined tar "A" or refined tar "B."

27. *Measurement and Payment*—The quantity of bitumen in the refined tar, to be paid for under this item, shall be the number of tons. determined in accordance with the paragraph headed "Samples" contained in the refined tar placed on the road in accordance with the specifications and requirements, or used as directed for other purposes. The percentage of bitumen determined by an average of the analyses of the acceptable samples taken by the Engineer during a given month shall be used as the basis for payment for the refined tar used during that month. Refined tar that is wasted shall not be included in the measurement under this item. The price stipulated in this item shall include the cost of furnishing, hauling and delivering the refined tar at the work, and all expenses incidental thereto.

SPECIFICATIONS FOR BITUMINOUS MACADAM PAVEMENT.

28. *General Description*—The bituminous macadam pavement shall consist of three courses of broken stone, separately constructed, laid to conform to the required grades and cross-sections, and constructed as hereinafter specified with bituminous material incorporated with the top or third course.

Broken Stone.

29. *Quality of Broken Stone*—All broken stone shall be clean, rough surfaced and sharp angled, of compact texture and uniform grain.

Tests For Broken Stone—The broken stone shall be subjected to abrasion tests and toughness tests conducted by the Engineer in accordance with methods adopted by the American Society for Testing Materials, August 15, 1908. The broken stone used for the construction of the first and second courses shall show a French coefficient of wear of not less than 7.0 and its toughness shall be not less than 6.0. The broken stone used for the construction of the third course and for the first and second applications of No. 1 broken stone shall show a French coefficient of wear of not less than 11.0 and its toughness shall not be less than 13.0.

30. *Sizes*—The sizes shall be in accordance with requirements as stated in the paragraph entitled "Sizes" in the specifications for "Broken Stone Road."

Construction.

31. *First Course*—After the sub-grade or sub-base course shall have been prepared as specified, a course of No. 4 broken stone shall be evenly spread so that it shall have, after rolling,the required thickness of three and one-half (3½) inches. The depth of loose broken stone shall be gauged by the use of strings between iron stakes, as directed. The spreading of the broken stone must be from piles dumped on boards provided for the purpose or from piles dumped alongside the road, or as directed by the Engineer. This course shall be thoroughly rolled with a twelve (12) to fifteen (15) ton road roller. The initial rolling shall begin at the sides of the road and continue towards the center and shall be kept up until the stone is keyed together and there is no disturbance of the stone ahead of the roller. After the first course has been compacted, it shall be evenly covered with a thin layer of

screenings. The quantity of screenings to be used shall be just sufficient to cover the larger stones and care shall be exercised to avoid the use of an excess of the screenings. This covering shall then be rolled as heretofore provided except that water shall be used in connection with the rolling as follows: After the screenings shall have been lightly rolled, water shall be sprinkled on the road surface just ahead of the roller, in such quantity as will prevent the sticking to the wheels of the roller of the fine material on the surface, and the combined spreading of screenings, watering and rolling shall be continued until the viods of the broken stone become so filled with the finer particles as to result in a wave of grout being pushed along the road surface by the front wheel of the roller. After the completion of the rolling, no teaming other than that necessary for bringing on the broken stone for the next course shall be allowed over the rolled broken stone. Should it be apparent after the rolling of the first course that the sub-grade material shall have become churned up into or mixed with the broken stone of this course, whether by reason of the rolling, or by hauling over the broken stone or otherwise, the Contractor shall at his own expense remove and replace such mixture of sub-grade material and broken stone with clean broken stone of the proper size and shall roll the material to produce a uniform, firm and even first course as required.

32. *Second Course*—On the completed first course shall be spread, in the manner specified in the preceding paragraph, No. 4 broken stone to form the second course. This broken stone shall be evenly spread to such a depth that it shall have, after rolling, the required thickness of three and one-half (3½) inches. The second course shall be compacted, puddled with screenings and water, and finished under the same provisions as prescribed for the first course. When the rolling shall have been completed, the surface of the second course shall be firm, even and true to the lines, grades and cross-

sections. If the surface is not slightly rough so as to afford a sufficient mechanical bond for the third course, it shall be broomed.

TOP COURSE, BITUMINOUS MACADAM PAVEMENT.

33. *Description of Top Course*—The top course of the bituminous macadam pavement shall consist of a third course of broken stone and two applications of bituminous material, each application being followed by the distribution of a layer of No. 1 broken stone, constructed as hereinafter specified.

BITUMINOUS MATERIAL.

34. *Asphalt Cement and Refined Tar*—The asphalt cement or refined tar, hereinafter referred to as bituminous material, used in the construction of the third course of the bituminous macadam pavement shall conform with either one of the specifications covering the chemical and physical properties of bituminous materials included under the item entitled "Asphalt Cements and Refined Tars for Bituminous Macadam Pavement."

35. *Heating Bituminous Materials*—Bituminous materials shall he heated in kettles or tanks so designed as to admit of even heating of the entire mass, with an efficient and positive control of the heat at all times. Asphalt cement shall be heated as directed by the Engineer to a temperature between 135° C. (275° F.) and 177° C. (350° F.) All asphalt cement heated beyond 177° C. (350° F.) shall be rejected. Refined tar shall be heated as directed by the Engineer to a temperature between 93° C. (200° F.) and 121° C. (250° F.). All refined tar heated beyond 121° C. (250° F.) shall be rejected. No tar shall be heated in kettles or tanks containing any oil or asphalt cement. Before changing from one type of material to another, kettles or tanks shall be scrupulously cleaned in order to avoid mixtures of the two. Any mixtures of different kinds of bituminous materials shall be rejected.

Thermometers Furnished by Contractors—The Contractor shall provide a sufficient number of accurate, efficient, sta-

tionary thermometers for determining the temperature of the bituminous material in kettles or tanks.

Construction.

36. *Third Course of Broken Stone*—On the completed second course, when thoroughly dry, shall be spread, in the manner above specified for the first course, dry No. 3 broken stone to form the third course. This broken stone shall be evenly spread to such a depth that it will have, after rolling, the required thickness of two and one-half (2½) inches. The third course shall be thoroughly compacted by dry rolling until the fragments of broken stone have just keyed together in accordance with the same provisions covering rolling as prescribed for the "First Course."

37. *First Application of Bituminous Material*—After the third course of broken stone shall have been thoroughly compacted as specified and when clean and thoroughly dry, the bituminous material shall be uniformly applied over the prepared surface of the third course by means of a pressure distributor as hereinafter specified. The asphalt cement, when applied, shall have a temperature between 135° C. (275° F.) and 177° C. (350° F.). The refined tar, when applied, shall have a temperature between 93° C. (200° F.) and 121° C. (250° F.). The total amount of bituminous material to be used in the first application shall not be less than one and one-half (1½) gallons nor more than one and three-quarters (1¾) gallons per square yard, the precise quantity being determined by the Engineer.

Pressure Distributor—The pressure distributor employed shall be so designated and operated as to distribute the bituminous materials specified uniformly under a pressure of not less than twenty (20) pounds nor more than seventy-five (75) pounds per square inch in the amount and between the limits of temperature specified. It shall be supplied with an accurate stationary thermometer in the tank containing the bituminous material and with an accurate pressure gauge so

located as to be easily observed by the Engineer while walking beside the distributor. It shall be so operated that, at the termination of each run, the bituminous material will be at once shut off. It shall be so designed that the normal width of application shall be not less than six (6) feet and so that it will be possible on either side of the machine to apply widths of not more than two (2) feet. The distributor shall be provided with wheels having tires each of which shall not be less than eighteen (18) inches in width, the allowed maximum pressure per square inch of tire being dependent upon the following relationship between the aforesaid pressure and the diameter of the wheel: For a two (2) foot diameter wheel, two hundred and fifty (250) pounds shall be the maximum pressure per linear inch of width of tire per wheel, an additional pressure of twenty (20) pounds per inch being allowed for each additional three (3) inches in diameter.

38. *First Application of No. 1 Broken Stone*—Immediately after the application of the bituminous material, a layer of dry No. 1 broken stone, not to exceed three-eighths (3/8) of an inch in thickness, shall be spread as directed by the Engineer over the surface of the bituminous material and shall be at once rolled as directed by the Engineer with a roller weighing between twelve (12) and fifteen (15) tons. During the rolling process, additional No. 1 broken stone shall be applied and brooomed until the voids in the upper portion of the third course are filled to the satisfaction of the Engineer.

39. *Second Application of Bituminous Material*—Prior to the second application of bituminous material, all loose No. 1 broken stone shall be swept from the surface of the pavement. When thoroughly clean and dry, a second application of bituminous material shall be uniformly applied over the surface by means of a pressure distributor as specified above. When applied the asphalt cement shall have a temperature between 135° C. (275° F.) and 177° C. (350° F.). When applied the refined tar shall have a temperature between 93° C. (200° F.) and 121° C. (250° F.). The total amount of bituminous ma-

terial to be used in the second application shall not be less than one-half (½) gallon nor more than three-quarters (¾) gallon per square yard, the precise quantity being determined by the Engineer.

40. *Second Application of No. 1 Broken Stone*—Immediately after the second application of bituminous material, a layer of dry No. 1 broken stone, not to exceed three-eighths (⅜) of an inch in thickness, shall be spread and broomed as directed by the Engineer over the surface of the bituminous material and thereafter at once rolled as directed by the Engineer with a roller weighing between twelve (12) and fifteen (15) tons. The rolling shall be continued and additional No. 1 broken stone shall be applied until a smooth, uniform surface is produced to the satisfaction of the Engineer.

41. *Seasonal and Weather Limitations*—No bituminous material shall be applied when the air temperature in the shade is below 10° C. (50° F.), except by the written permission of the Engineer.

PAYMENT.

42. *Measurement and Payment*—The quantity of bituminous macadam pavement to be paid for under this item shall be the number of square yards, measured horizontally, satisfactorily completed in accordance with the specifications. The price stipulated in this item shall include the furnishing, crushing and screening of the different sizes of broken stone, the heating and distributing of the bituminous material, and all materials, work and expenses incidental to the completion of the bituminous macadam pavement except the furnishing of the bituminous material, which will be included for payment under the item entitled "Asphalt Cements and Refined Tars for Bituminous Macadam Pavements."

SPECIFICATIONS FOR ASPHALT CEMENTS AND REFINED TARS FOR BITUMINOUS MACADAM PAVEMENTS.

43. *Previous Service*—The Contractor will be required to show, to the satisfaction of the Engineer, that the Company

manufacturing the asphalt cement or refined tar he proposes to use under a given specification has, for a perod of at least two years, manufactured asphalt cement or refined tar in a thoroughly equipped plant, and that asphalt cement or refined tar manufactured of bituminous material obtained from a similar source to that which he proposes to use shall have been in continuous and successful use in bituminous pavements constructed by the mixing method or in bituminous macadam pavements for a period of at least two years previous to the date of the letting in which his proposal was submitted.

44. *Asphalt Cement "A" Optional With Asphalt Cements "B," "C," "D" and Refined Tars "E" and "F."*

(I) Asphalt Cement "A" shall be homogeneous, free from water and shall not foam when heated to 177° C. (350° F.).

(II) It shall show a flash point of not less than 205° C. (400° F.) when tested in the New York State Board of Health Closed Oil Tester.

(III) Its specific gravity, at a temperature of 25° C. (77° F.) shall be not less than 0.960 nor more than 1.000.

(IV) When tested with a standard No. 2 needle by means of a standard penetrometer, it shall show penetrations within the following limits for the conditions stated, the penetrations being expressed in hundredths of a centimeter, 100 gram load, 5 seconds, at 25° C. (77° F.), from 100 to 120; 200 gram load, 1 minute, at 4° C. (39° F.), not less than 50.

(V) Its melting point as determined by the cube method shall be not less than 60° C. (140° F.).

(VI) When 50 grams of the material is maintained at a uniform temperature of 163° C. (325° F.) for 5 hours in an open cylindrical tin dish 5½ centimeters (about 2¼ inches) in diameter, with vertical sides measuring approximately 3½ centimeters (about 1½ inches) in depth, the loss in weight shall not exceed 2.0 per cent of the original weight of the sample.

The penetration of the residue, when tested as described in Clause (IV) with a standard No. 2 needle under a load of

100 grams, for 5 seconds at 25° C. (77° F.) shall be not less than one-half the penetration of the original material tested under the same condition.

(VII) Its bitumen as determined by its solubility in chemically pure carbon disulphide at room temperature, shall be not less than 99.5 per cent.

(VIII) It shall be soluble in chemically pure carbon tetrachloride at room temperature, to the extent of not less than 99.5 per cent. of its bitumen as determined by Clause (VII).

(IX), It shall be soluble in 86° to 88° Baume paraffin naphtha, of which at least 85.0 per cent distills between 35° and 65° C. (95° and 149° F.), to the extent of not less than 75.0 per cent. nor more than 85.0 per cent of its bitumen as determined by Clause (VII.)

(X) It shall yield not less than 8.0 per cent nor more than 12.0 per cent of fixed carbon.

45. *Asphalt Cement "B" Optional With Asphalt Cements "A," "C," "D," and Refined Tars "E" and "F."*

(I) Asphalt cement "B" shall be homogeneous, free from water and shall not foam when heated to 177° C. (350° F.).

(II) It shall show a flash point of not less than 205° C. (400° F.) when tested in the New York State Board of Health Closed Oil Tester.

(III) Its specific gravity, at a temperature of 25° C. (77° F.) shall be not less than 1.000 nor more than 1.030.

(IV) When tested with a standard No. 2 needle by means of a standard penetrometer, it shall show penetrations within the following limits for the conditions stated, the penetrations being expressed in hundredths of a centimeter, 100 gram load, 5 seconds, at 25° C. (77° F.), from 90 to 110; 200 gram load, 1 minute, at 4° C. (39° F.), not less than 15.

(V) Its melting point as determined by the cube method shall be not less than 30° C. (86° F.).

(VI) When 50 grams of the material is maintained at a uniform temperature of 163° C. (325° F.) for 5 hours in an

open cylindrical tin dish 5½ centimeters (about 2¼ inches) in diameter, with vertical sides measuring approximately 3½ centimeters (about 1½ inches) in depth, the loss in weight shall not exceed 2.0 per cent. of the original weight of the sample.

The penetration of the residue, when tested as described in Clause (IV) with a standard No. 2 needle under a load of 100 grams, for 5 seconds at 25° C. (77° F.) shall be not less than one-half the penetration of the original material tested under the same conditions.

(VII) Its bitumen, as determined by its solubility in chemically pure carbon disulphide at room temperature, shall be not less than 99.5 per cent.

(VIII) It shall be soluble in chemically pure carbon tetrachloride at room temperature, to the extent of not less than 99.5 per cent of its bitumen as determined by Clause (VII).

(IX) It shall be soluble in 86° to 88° Baume paraffin naphtha, of which at least 85.0 per cent. distills between 35° and 65° C. (95° and 149° F.), to the extent of not less than 75.0 per cent. nor more than 85.0 per cent. of its bitumen as determined by Clause (VII).

(X) It shall yield not less than 9.0 per cent. nor more than 13.0 per cent. of fixed carbon.

46. *Asphalt Cement "C" Optional With Asphalt Cements "A," "B," "D," and Refined Tars "E" and "F."*

(I) Asphalt cement "C" shall be homogeneous, free from water and shall not foam when heated to 177° C. (350° F.).

(II) It shall show a flash point of not less than 205° C. (400° F.) when tested in the New York State Board of Health Closed Oil Tester.

(III) Its specific gravity, at a temperature of 25° C. (77° F.) shall be not less than 1.025 nor more than 1.045.

(IV) When tested with a standard No. 2 needle by means of a standard penetrometer, it shall show penetrations within the following limits for the conditions stated, the penetrations being expressed in hundredths of a centimeter: 100 gram load,

5 seconds, at 25° C. (77° F.), from 110 to 130; 200 gram load, 1 minute, at 4° C. (39° F.) not less than 30.

(V) Its melting point as determined by the cube method shall be not less than 40° C. (104° F.).

(VI) When 50 grams of the material is maintained at a uniform temperature of 163° C. (325° F.) for 5 hours in an open cylindrical tin dish 5½ centimeters (about 2¼ inches) in diameter, with vertical sides measuring approximately 3½ centimeters (about 1½ inches) in depth, the loss in weight shall not exceed 2.0 per cent. of the original weight of the sample.

The penetration of the residue, when tested as described in Clause (IV) with a standard No. 2 needle under a load of 100 grams for 5 seconds at 25° C. (77° F.) shall be not less than one-half the penetration of the original material tested under the same conditions.

(VII) Its bitumen, as determined by its solubility in chemically pure carbon disulphide at room temperature, shall be not less than 99.5 per cent.

(VIII) It shall be soluble in chemically pure carbon tetrachloride at room temperature, to the extent of not less than 99.5 per cent of its bitumen as determined by Clause (VII).

(IX) It shall be soluble in 86° to 88° Baume paraffin naphtha, of which at least 85.0 per cent distills between 35° and 65° C. (95° and 149° F.) to the extent of not less than 70.0 per cent. nor more than 80.0 per cent of its bitumen as determined by Clause (VII).

(X) It shall yield not less than 12.0 per cent. nor more than 17.0 per cent. of fixed carbon.

47. *Asphalt Cement "D" Optional With Asphalt Cements "A," "B," "C," and Refined Tars "E" and "F."*

(I) Asphalt cement "D" shall be homogeneous, free from water and shall not foam when heated to 177° C. (350° F.).

(II) It shall show a flash point of not less than 163° C. (325° F.) when tested in the New York State Board of Health Closed Oil Tester.

(III) Its specific gravity, at a temperature of 25° C. (77° F.) shall be not less than 1.035 nor more than 1.060.

(IV) When tested with a standard No. 2 needle by means of a standard penetrometer, it shall show penetrations within the following limits for the conditions stated, the penetrations being expressed in hundredths of a centimeter: 100 gram load, 5 seconds, at 25° C. (77° F.), from 130 to 160; 200 gram load, 1 minute at 4° C. (39° F.), not less than 30.

(V) When tested by means of the New York Testing Laboratory Float Apparatus, the float shall not sink in water maintained at 66° C. (150° F.) in less than 120 seconds nor more than 180 seconds.

(VI) When 50 grams of the material is maintained at a uniform temperature of 163° C. (325° F.) for 5 hours in an open cylindrical tin dish 5½ centimeters (about 2¼ inches) in diameter, with vertical sides measuring approximately 3½ centimeters (about 1½ inches) in depth, the loss in weight shall not exceed 3.0 per cent of the original weight of the sample.

The penetration of the residue, when tested as described in Clause (IV) with a standard No. 2 needle under a load of 100 grams, for 5 seconds at 25° C. (77° F.) shall be not less than one-half the penetration of the original material tested under the same conditions.

(VII) Its bitumen as determined by its solubility in chemically pure carbon disulphide at room temperature, shall be not less than 94.0 per cent nor more than 98.0 per cent.

(VIII) It shall be soluble in chemically pure carbon tetrachloride at room temperature, to the extent of not less than 98.5 per cent. of its bitumen as determined by Clause (VII).

(IX) It shall be soluble in 86° to 88° Baume paraffin naphtha, of which at least 85.0 per cent. distills between 35° and 65° C. (95° and 149° F.) to the extent of not less than 75.0 per cent. nor more than 85.0 per cent. of its bitumen as determined by Clause (VII).

(X) It shall yield not less than 11.0 per cent. nor more than 14.0 per cent. of fixed carbon.

(XI) Upon ignition it shall yield not less than 1.0 per cent. nor more than 3.0 per cent. of ash.

48. *Refined Tar "E" Optional With Asphalt Cements "A," "B," "C," "D," and Refined Tar "F."*

(I) Refined tar "E" shall be homogeneous, free from water, and shall not foam when heated to 121° C. (250° F.).

(II) Its specific gravity at a temperature of 25° C. (77° F.) shall be not less than 1.150 nor more than 1.200.

(III) When tested by means of the New York Testing Laboratory Float Apparatus, the float shall not sink in water maintained at 50° C. (122° F.) in less than 120 nor more than 150 seconds.

(IV) Its bitumen as determined by its solubility in chemically pure carbon disulphide at room temperature, shall be not less than 95.0 per cent., and it shall show not more than 0.2 per cent. ash upon ignition of the material insoluble in carbon disulphide.

(V) When distilled according to the tentative method recommended by Committee D-4 of the American Society for Testing Materials in 1911, it shall yield not more than 0.5 per cent. distillate at a temperature lower than 170° C. (338° F.); not more than 12.0 per cent shall distill below 270° C. (518° F.), and not more than 25.0 per cent. shall distill below 300° C. (572° F.)

(VI) The total distillate from the test made in accordance with Clause (V) shall have a specific gravity at a temperature of 25° C. (77° F.) of not less than 0.980 nor more than 1.020.

(VII) The melting point, as determined in water by the cube method, of the pitch residue remaining after distillation to 300° C. (572° F.) in accordance with the test described in Clause (V), shall be not more than 75° C. (167° F.).

49. *Refined Tar "F" Optional With Asphalt Cements "A," "B," "C," "D," and Refined Tar "E."*

(I) Refined tar "F" shall be homogeneous, free from water, and shall not foam when heated to 121° C. (250° F.)

(II) Its specific gravity at a temperature of 25° C. (77° F.) shall be not less than 1.180 nor more than 1.300.

(III) When tested by means of the New York Testing Laboratory Float Apparatus, the float shall not sink in water maitained at 50° C. (122° F.) in less than 150 nor more than 180 seconds.

(IV) Its bitumen as determined by its solubility in chemically pure carbon disulphide at room temperature, shall be not less than 80.0 per cent. nor more than 95.0 per cent., and it shall show not more than 0.2 per cent. ash upon ignition of the material insoluble in carbon disulphide.

(V) When distilled according to the tentative method recommended by Committee D-4 of the American Society for Testing Materials in 1911, it shall yield not more than 0.5 per cent. distillate at a temperature lower than 170° C. (338° F.); not more than 10.0 per cent. shall distill below 270° C. (518° F.), and not more than 20.0 per cent. shall distill below 300° C. (572° F.).

(VI) The total distillate from the test made in accordance with Clause (V) shall have a specific gravity at a temperature of 25° C. (77° F.) of not less than 1.020.

(VII) The melting point, as determined in water by the cube method, of the pitch residue remaining after distillation to 300° C. (572° F.) in accordance with the test described in Clause (V), shall be not more than 75° C. (167° F.).

50. *Delivery*—The asphalt cement or refined tar shall be delivered in suitable containers, far enough in advance of its use in the work to permit the necessary tests to be made. Each container shall be plainly labeled with the trade name of the asphalt cement or refined tar, name of manufacture, gross weight and net weight. Each shipment and each carload shall be kept separate.

Bills of Lading—The Contractor shall furnish the Engineer on or before the arrival of each shipment at or near the site of the work, bills of lading, or correct copies thereof, which shall state the trade name of the asphalt cement or refined

tar, and the name and address of the Company manufacturing and supplying it.

51. *Samples*—Samples will be taken by the Engineer from each carload of asphalt cement or refined tar when delivered at the work, unless satisfactory arrangements can be made for sampling before shipment. Such samples shall be analyzed by the Engineer to assure the delivery of an asphalt cement or refined tar of the specified quality and to determine, for purpose of payment, the quantity of bitumen.

52. *Work Included*—Under this item the Contractor shall furnish and deliver on the work at such points as directed an asphalt cement or refined tar which conforms with the specifications of any one of the asphalt cements or refined tars given above.

53. *Measurement and Payment*—The quantity of bitumen in the asphalt cement or refined tar, to be paid for under this item, shall be the number of tons, determined in accordance with the paragraph headed "*Samples*," contained in the asphalt cement or refined tar placed in the pavement in accordance with the specifications and requirements, or used as directed for other purposes. The percentage of bitumen determined by an average of the analyses of the acceptable samples taken by the Engineer during a given month shall be used as the basis for payment for the asphalt cement or refined tar used during that month. Asphalt cement or refined tar that is wasted shall not be included in the measurement under this item. The price stipulated in this item shall include the cost of furnishing, hauling and delivering the asphalt cement or refined tar at the work, and all expenses incidental thereto.

REPORT OF SUB-COMMITTEE ON SPECIFICATIONS FOR ASPHALT PAVING.

The report of the Committee on Specifications for Asphalt Paving was submitted verbally by the Chairman, F. T. Smith, as shown in the following transferred from the minutes of the Convention:

MR. F. T. SMITH: We have been considering the specifications adopted by the A. S. P. S. and the A. S. M. I., have gone into detail, received many suggestions in connection with them, and have endeavored in the specifications presented to the General Committee to combine what appeared to us to be the best features of both specifications. We have taken as a skeleton for our modification the specifications adopted by the A. S. M. I., in 1910, 1911 and 1912. The changes which we have made in these specifications are as follows:

In the first paragraph under Materials, in the fifth line we have stricken out the words "and upon the character of the material used," because in the line above it says "depending upon their character."

Under the head of Methods of Testing, in the description of the penetration of the machine, we have inserted the words "without appreciable friction," in connection with the phrase which explains that all penetrations at 77 degrees F. are expressed in hundredths of a centimeter, and are to be taken (except where otherwise specified) with a No. 2 needle acting "without appreciable friction." If there is appreciable friction, the needle will not penetrate as far as it should, and you would not get, perhaps, the correct reading for penetration.

Under the heading Refined Asphalts, at the end of the paragraph "by suitable and approved methods of refining" was too indefinite, in the opinion of the committee, and we suggest this expression be substituted: "by such methods of refining as will produce a product complying with the requirements hereinafter given."

On the second and third lines from the bottom of the first page, the words "and shall in all cases be conducted after the most approved manner" were apparently of no value, and we eliminated them, with the idea making this specification as definite as possible. It is impossible to define an approved manner, and what may be an approved method today is not tomorrow. The following sentence reads "Every refined asphalt admitted under these specifications shall be equal in quality, etc." The committee believed that should be modified so as to put it clearly within the discretion of the engineer, so after "under these specifications shall" were inserted the words "If required by the engineer." The idea was that if a certain brand of X asphalt were submitted as X asphalt, it had normal characteristics which would be found in all good shipments of that material, notwithstanding these specifications provide for a mix of X with Y, provided they meet other requirements of the specifications; and it was held that if X were submitted as X, they would prefer to reject that material if it didn't come up to the standard of X. Others held that as long as it complied with the detailed requirements afterward embodied in the specifications, it made no difference whether it complied wholly with the requirements of X asphalt. Therefore we put in the clause making it optional with the engineer.

We inserted a paragraph at the conclusion of the first paragraph on the second page of the specifications to the effect that "Asphalt obtained by the refining of natural liquid bitumens shall not be reduced in the refining process to a penetration at 77 degrees F. of less than 30." That is in accord with the requirements of the A. S. P. S., and in our judgment is proper.

In clause a, we have made it read "All shipments of refined asphalt of any one kind shall be marked with batch numbers, and shall be uniform, etc." The marking with batch numbers greatly facilitates inspection. This change is in accord with A. S. P. S. specifications. And after the word "vary" in second line of a, we inserted "from maximum to minimum," to make the clause clearer.

Under clause a under Fluxes five seconds should be one second, a typographical error. Paragraph c we have made to read "When 20 grams of the flux are heated for five hours at 325 F. in a tin box 2¼ inches in diameter and ¾-inch deep, etc," specifying the amount of flux to be used in the test, as well as the diameter of the box.

Clause d was modified to strike out the words New York State. The New York State oil tester requires approximately half a pint of material. Many samples submitted are not large enough to permit the use of the flash test, and another test is called for. We have stricken out the words making the use of the New York State oil tester mandatory, and simply leave it a closed oil tester. That is practically in accord with the A. S. P. S.

In clause e carbon tetra chloride has been substituted for carbon disulphide, as narrowing somewhat the limits of the specifications, making them better, and so far as that test does indicate improper heating of the material, eliminating that; in other words, this standard is slightly higher than the old standard, but no flux producer has objected to this, and it is in accord with the A. S. P. S.

Under the head of Binder Stone a few changes have been made. The old specifications called for stone running up to 1¼ inches. The binder course laid under different conditions varies from 1 to 1½, and it would be improper to say 1¼ inch in an inch binder course. We have changed the second sentence to read "95 per cent. of the binder aggregate shall pass a screen having circular openings whose diameter shall be three-fourths the thickness of the binder course to be laid." We allow a five per cent. variation to provide for unavoidable fluctuations in the product from the quarry.

A provision providing for the mixing of sand with the material from the screen, to make a close binder, has been put in under Binder Stone, rather than under the head of Binder Preparation under the specifications. It is the same as before.

Slight changes have also been made in the required mesh composition of the binder stone, as we found these were some-

what limiting even for 1½-inch binder, and also where we call for binder aggregate to pass a screen whose openings are three-fourths the thickness of the binder course, it would be improper to set up mesh composition for stone calling for 1¼-inch. That has been eliminated. The requirement for 10-mesh remains as it was. The requirement for half-inch stone has been changed from 10 to 35, to 20 to 50, as being more nearly the limits which will insure the use of a proper binder stone. In specifying the mesh composition of binder stone, we adhere to the A. S. M. I. and depart from the A. S. P. S., which required no mesh composition whatever for their binder stone. The same is true of sand. We have made some slight changes in the sand mesh composition. The old specifications called for total passing of 80, and retained on 200-mesh, 20 to 35. We have made that 20 to 40. The 50-mesh limits have been broadened from 15 to 40, to 5 to 40. The same is true of the 40-mesh, changed from 10 to 30, to 5 to 30; and the 30-mesh, changed from 8 to 25, to 5 to 25. We have drawn them so broadly that we won't have any trouble with them. We have also specified a total passing the 10 and retained on 40, 12 to 45; that is a total which would include 30-mesh, 20 and 10. That is in accord with the individual requirements for the 30, 20 and 10; the two minimums added up, and the two maximums added up, and those two give you the limits.

In the last two lines of first paragraph under Samples, it was suggested they might be construed to mean that the engineer might give consent for the contractor to use a material which did not comply with the requirements of these specifications; so we have added "and provided that it complies in all respects with the requirements of these specifications."

Under Asphalt Cement, in the second paragraph we have added "at a temperature between 275 and 400 F." after the word "together" in the second line, the idea being that we wish to specify the temperature to which the materials were to be subjected during the process of melting and blending the asphalt and the flux. The word "not" is substituted for "never" in the fourth line of the same paragraph.

The last phrase of that second paragraph seemed very broad and to mean little, and we changed it to read "Excessive agitation with steam or air which will injure the cement must not be used," because those are the points we want to cover. Excessive agitation will harden the asphalt cement materially, and if air is used it lessens its ductility.

Under Regulations, a, it has been contended that the phrase "oily to the touch," is not definite enough to be of value. Personally, it means a great deal to me, but it was the judgment of the committee that it be stricken out. The statement was also made in clause a that "the various bituminous ingredients contained in it shall be in a state of complete solution." That is absolutely not true of certain asphalts of well recognized paving value, and it appeared that portion of that clause should also be eliminated. It was changed so as to read "It shall be thoroughly homogeneous."

In clause b it was necessary to change the limits, broaden them to cover modern practice, and when we broadened them it seemed to make them so very broad that we tried to define two classes, one for heavy traffic, and one for lighter traffic work. We changed it to read "It shall have a penetration of from 30 to 55 for heavy traffic and 55 to 85 for light traffic streets, depending upon the sand and asphalt used and the local climatic conditions."

Clause c was modified in the same way, regarding the flash test, as for flux, striking out the words "New York State."

The flash limit also was raised from 300 to 350. The 300 was a typographical error.

In the next clause, the same change was made in that, simply descriptive of the size of the tin and the amount to be used.

Clause e, the ductility test, was slightly changed because of several objections. It has been made to read "Either the asphalt cement or its pure bitumen, when made into a briquette (Dow Mould) shall at 50 penetration (77 F.) have a ductility of not less than 20 cms., etc."

The next paragraph was made to read at the end of it, "above 50 penetration, and a corresponding allowance will be made below 50 penetration." That is substantially in accord with the A. S. P. S.

MR. HOWARD: The very first of the second line on this page, don't you mislead when you state that the ductility should be not less than 20 centimeters?

MR. SMITH: Yes. I thank you for calling my attention to that. That should be 30 centimeters.

Under Binder, Preparation, the temperature of the stone was formerly limited to between 200 and 325; we have raised the minimum to 225. We have also added, after "stone" in the first line, "or stone and sand," because we provide for the mixture of sand or gravel with stone if desired.

The clause beginning in the fifth line from the bottom of that same paragraph, "In such proportions that the resulting binder shall have life and gloss without an excess of asphalt cement, and the mixing shall be continued," has been stricken out, for the reason that a close binder will not be a glossy binder, and it would be absurd to call for a close binder glossy. It would be too rich, and sloppy and objectionable.

Under the paragraph Laying, we have changed slightly the verbiage of the A. S. M. I. regarding covering of materials in transit with a canvas cover, so as to agree with the A. S. P. S., we believing that was a clearer form of expression. Also we have specified the temperature of the binder when delivered on the street, which was not the case clearly in the old A. S. M. I., but was the case in the A. S. P. S. specifications.

The provision regarding depth of finished binder has been changed. We realize that the binder course should be laid as nearly as possible of uniform thickness. When work has been carelessly done, we have added binder almost ad libitum, you might say, to fill up the places in the concrete, to bring the surface of the finished binder parallel to the contour of the finished street. Sometimes there is a four-inch thickness of binder, which of course is improper and should be avoided.

We provide for that by changing the provision to read as follows, we also changing "depth" to "thickness": "The thickness of the finished binder shall average ...... inches" (the blank to be filled out by the engineer) "and not more than a forty per cent. variation from the average thickness specified will be permitted at any one spot." If the course were two inches, this forty per cent. variation provides all the variation that is really necessary. We have eliminated the provision that permitted fat spots in the binder not exceeding a certain size. That was considered dangerous, and under this specification, it must be cut out, if it is too rich in any one spot, regardless of the area. The old specifications said that no more binder should be laid at any one time than can be covered by two days' run of the paving plant. That has been cut to one day. The binder must be covered within one day of laying with surface mixture. That prevents dust getting on the surface of the binder, and makes the adherence much better. In New York they require them to cover the binder entirely by night, any binder laid during the day must be covered by surface mixture, and while that perhaps could not be enforced all over the country, we have come as near to that as possible by making it one day.

Under the head of Requirements of Finished Pavement, content was 5 to 8 per cent. of bitumen soluble, etc. We cut that to 4 to 7 per cent., which seemed to us to be better limits. As to the finished binder passing a screen, we have made that as follows: "from fifteen to thirty per cent. of material passing a ten-mesh screen, and from twenty to fifty per cent. of material passing a one-half inch screen."

Next, under Wearing Surface, Preparation, we have called for definite proportions by weight, and that is a little broader than the A. S. P. S. specification. We have changed the minimum temperature of sand from 250 to 275 degrees. The old specifications called for the mixing of sand with filler first, and then the addition of the asphalt cement. Modern practice is tending toward the mixing of sand and asphalt cement first,

and then the addition of dust in order to reduce the loss of dust in the atmosphere. In our judgment, there is no objection to that practice, and we did not feel it would be right to specify that they couldn't do that if they wanted to.

Slight changes were made regarding the thickness to be required for the finished surface, in accord with those just read for the binder. Also the covering with canvas covers in transit.

On the rolling we have strengthened that clause, narrowing it a little by saying that the rolling shall be carried on continuously at the rate of not more than 200 square yards per hour per roller. We considered that one roller is not capable of taking care of more than 200 square yards of finished surface an hour. If the plant is large enough to do more than that, then they should have more than one roller. We have also inserted that excessive use of water on the steam roller when compressing the pavement will not be permitted, and believe that is important.

Under the head of Requirements for Finished Pavement, instead of putting it in the form of reading matter as here, we have drawn up a table somewhat in the form of the A. S. P. S. table, as making it more clear to the engineer what his analysis should show, and based on the mesh composition of the sand and raw materials going into it.

In condition at expiration of guarantee, we made a slight change in clause a, as follows: "Have a contour substantially conforming to that of the pavement as first laid and free from depressions, etc." Otherwise, the clause is the same. We have made clause b to read "Be free from cracks or depressions showing, etc.," having inserted the words "or depressions."

There are no changes under repairing. It was suggested that certain cities were following the practice of mixing a certain amount of old asphalt pavement with their binder, in order to make it close, rather than to add sand, and we were requested to draw up a clause providing for that. On consultation with the general committee, it was decided not to

incorporate this clause in the specifications, but to add a foot note stating that while that was descriptive of practice in certain cities, we did not feel like recommending it for a provision of a general specification, but that any city official who desired to adopt it, we would suggest do so as per the following clause: "With the permission of the city engineer, not to exceed twenty per cent. of crushed old asphalt surface mixture of suitable character may be used in combination with the binder stone, provided that such mixture produces a binder complying in all respects with the requirements of these specifications."

In addition, we have prepared totally new material covering methods for testing and sampling both. These methods are not set forth as authoritative official methods. There is too much room for dispute in certain of these methods, and all we have tried to do is to describe methods which are in general use and sufficiently accurate for the purpose. Our preamble to that is as follows: "The following methods are recommended as being sufficiently accurate for general use. In cases of dispute the standard methods adopted by the American Society for Testing Materials must be employed." That society has not adopted standard methods for all of these tests, but where they have, we think in cases of dispute they should be adopted.

We have also endeavored for the benefit of engineers not familiar with asphalt pavement in its technical requirements, to give a brief description under each method of test, first, as to what the test means, and, second, as to the ordinary limits of accuracy of the test, in order to avoid rejection of materials which might be closer to the specification requirements than the accuracy of the test made.

On the question of sampling, a good deal of ignorance at times is manifested by the samples sent in for test, and we have tried to give some things to be avoided in sampling materials, and also to cover the sizes of samples of different arti-

cles to be sent in. This is not official, and it is only intended for the assistance of the engineer.

SPECIFICATIONS FOR SHEET ASPHALT PAVING.

Adopted October 8, 1914.

NOTE—These specifications will be modified from time to time to keep them fully up to date. Suggestions as to modifications or additions are solicited and should be sent to the Secretary, or to Francis P. Smith, 131-3 East 23d street, New York City, Chairman of the Sub-Committee on Specifications for Asphalt Paving, and George W. Tillson, Boro Hall, Brooklyn, N. Y., Chairman of General Committee on Standard Specifications.

[NOTE—Italics denote new matter, changes from the former specifications. All of the matter on testing and sampling, sections 20 to 32, is also new.]

GENERAL DESCRIPTION.

1. Upon the foundation prepared and laid as elsewhere herein specified, shall be laid the pavement proper. This shall consist of:

1. A binder course ... inches in thickness when compressed.

2. An asphalt wearing surface ... inches in thickness when compressed.

MATERIALS.

2. The materials used must comply with the requirements of these specifications and be suitable for use upon the street or streets to be paved. They shall be mixed in definite proportions by weight, depending upon their character, and the traffic upon the street, and such materials and proportions must be satisfactory to the Engineer.

3. *Methods of Testing*—All tests herein specified must be conducted according to official methods on file in the office of the Engineer. All penetrations at 77 degrees Fahrenheit are expressed in hundredths of a centimeter and are to be taken

(except where otherwise specified) with a number two needle acting for five (5) seconds *without appreciable friction* under a total weight of one hundred (100) grams.

4. *Refined Asphalts*—The refined asphalts admitted under these specifications shall be prepared from a natural mineral bitumen, either solid or liquid, or from combinations thereof, by *such methods of refining as will produce a product complying with the requirements hereinafter given.*

The preparation and refining of all asphalts admitted under these specifications shall be subject to such inspection at the paving plants and refineries as the Engineer may direct. Every refined asphalt admitted under these specifications, *if required by the Engineer*, shall be equal in quality to the recognized standard for its particular kind or type of asphalt. If desired, the Contractor may use an asphalt cement prepared at the refinery. To be acceptable this asphalt cement must comply with the foregoing general requirements for refined asphalt, as well as requirements a, b, c, d, and e for asphalt cement.

Asphalt obtained by the refining of natural liquid bitumens shall not be reduced in the refining process to a penetration at 77 degrees F. of less than 80.

All refined asphalts admitted under these specifications must comply with the following requirements:

a. All shipments of refined asphalt of any one kind *shall have the batch number plainly marked on each package or container and* shall be uniform in consistency and composition and shall not vary *from maximum to minimum* more than fifteen (15) points in penetration at 77 degrees F.

b. Ninety-eight and one-half (98½) per cent. of the total bitumen of all refined asphalts shall be soluble in carbon tetrachloride.

c. When made into an asphalt cement by the use of such materials and methods as are described in these specifications, they must produce an asphalt cement complying with all the requirements elsewhere set forth herein for asphalt cements.

5. *Fluxes*—These shall be the residues obtained by the distillation of paraffine, asphaltic or semi-asphaltic petroleums. They shall be of such character that they will combine with the asphalt to be used to form an acceptable and approved asphalt cement complying with the requirements of these specifications. All residuums must pass the following general tests:

a. They must have a penetration greater than three hundred and fifty (350) with a No. 2 needle at 77 degrees F. under fifty (50) grams weight for *one* second.

b. They shall have a specific gravity at *77 degrees F.* between 0.92 and *1.02.*

c. When *twenty (20) grams of the flux are* heated for five (5) hours at 325 degrees F. in a tin box two and one-quarter (2¼) inches in diameter *and three-quarters (¾) of an inch deep* after the manner officially prescribed, *the loss* shall not *exceed* five (5) per cent. by weight and the residue left after such heating shall flow at 77 degrees F.

d. They shall not flash below 350 degrees F. when tested in a closed oil tester.

e. They shall be soluble in carbon *tetra-chloride* to the extent of not less than *ninety-nine (99)* per cent.

6. *Binder Stone*—This shall be clean, hard, *broken,* stone, free from any particles that have been weathered, or are soft. If the stone does not contain the proper amount of material passing the one-half (½) inch screen, the deficiency may be made up by the addition of gravel or sand. *Ninety-five (95) per cent. of the binder aggregate shall pass a screen having circular openings whose diameter shall be three-quarters (¾) the thickness of the binder course to be laid. The remaining five (5) per cent. shall not exceed in their smallest dimension the thickness of the binder course to be laid.* The *binder aggregate* shall be so graded from coarse to fine as to have the following mesh composition (sieves to be used in the order named):

Passing:

10 mesh	15 to 35%	Total passing ½" .... *35 to 85%*
½-inch circular opening and retained on 10 mesh	*20 to 50%*	

The above limits as to mesh composition are intended to provide for such permissible variations as may be rendered necessary by the available sources of supply and the character of the work to be done. The mesh composition and character of the stone may be varied, within the limits above specified, at the discretion of the Engineer, depending upon the kind of asphalt used and the traffic conditions upon the street or streets to be paved.

7. *Sand*—The sand shall be hard, clean grained and moderately sharp. On sifting it shall have the following mesh composition, (sieves to be used in the order named):

Passing:

200 mesh........................	0 to 5%	Total passing 80 mesh and retained on 200 mesh...20 to 40%
100 mesh and retained on 200 mesh	10 to 25%	
80 mesh and retained on 100 mesh	6 to 20%	
50 mesh and retained on 80 mesh	5 to 40%	
40 mesh and retained on 50 mesh	5 to 30%	
30 mesh and retained on 40 mesh	5 to 25%	*Total passing 10 mesh and retained on 40 mesh....12 to 45%*
20 mesh and retained on 30 mesh	5 to 15%	
10 mesh and retained on 20 mesh	2 to 10%	
8 mesh and retained on 10 mesh	0 to 5%	

On very light traffic streets a coarser sand may be used with the approval of the Engineer, but in no case shall a sand be employed that contains less than a total of fifteen (15) per cent. passing an 80 mesh sieve, such total to contain not more than five (5) per cent. (calculated on the original sand) passing a 200 mesh sieve, or a mixture of seventy-five (75) per cent. of sand of the character above specified and twenty-five (25) per cent. of stone screenings passing a one-quarter (¼) inch screen and retained on a 10 mesh screen, may be employed.

The above limits as to mesh composition are intended to provide for such permissible variations as may be rendered necessary by the available sources of supply and the character of the work to be done. The mesh composition and character of the sand may be varied, within the limits above specified, at the discretion of the Engineer, depending upon the kind of asphalt used and the traffic conditions upon the street or streets to be paved.

Filler—This shall be thoroughly dry limestone dust or dust from other equally satisfactory stone or Portland cement, the whole of which shall pass a 30-mesh-per-linear-inch screen and at least 66 per cent. of which shall pass a 200-mesh-per-linear-inch screen. The surface mixture shall contain from 6 to 20 per cent. of this filler, depending upon the kind of sand and asphalt used and the traffic conditions upon the street or streets to be paved.

8. *Samples*—One (1) pound samples of the refined asphalt, petroleum flux and asphalt cement that the Contractor proposes to use in his work, together with a statement as to the source, character and proportions of the materials composing them, must be handed in with his bid and no contract shall be awarded to any bidder whose samples do not comply in every respect with these specifications. No asphalt other than that specified in his bid shall be used by any Contractor except with the written consent of the Engineer *and provided that it complies in all respects with the requirements of these specifications.*

In addition to the samples submitted with the bid, other samples taken from and actually representative of the refined asphalt, petroleum flux, sand, filler and *binder stone* to be used upon the street shall be submitted to the Engineer before the use of such materials in the work is permitted. Except at his option, no work on binder or surface shall be commenced within three weeks from the date when such samples were submitted and in no case shall they be used until they have been examined and approved by him. Whenever, during the course of the work, new deliveries of paving materials are received by the Contractor samples of these shall at once be submitted to the Engineer and their use in the work will not be permitted until they have been examined and approved by him.

ASPHALT CEMENT.

9. *Preparation*—The asphalt cement shall be composed of refined asphalt, or asphalts and flux, where flux is required,

of the character elsewhere herein specified and must be of a suitable degree of penetration.

The proper proportions of the refined asphalt, or asphalts, and flux, shall be melted together *at a temperature between 275 and 400 degrees F.* and thoroughly agitated by suitable appliances until they are completely blended into a homogeneous asphalt cement. *Thereafter,* the asphalt cement must *not* be heated to a temperature exceeding 350 degrees F. If the asphalt cement contains material that will separate by subsidence while it is in a molten condition, it must be thoroughly agitated before drawing from storage and while in use in the supply kettles. *Excessive* agitation *with steam or air* which will injure the cement must *not* be used.

The refined asphalt or asphalts and flux comprising the asphalt cement shall, when required, be weighed separately in the presence of the authorized inspectors or agents of the Engineer.

10. *Requirements*—The asphalt cement shall comply with the following requirements:

a. It shall be thoroughly homogenous.

b. It shall have a penetration at 77 degrees F. *of from 30 to 55 for heavy traffic streets and 55 to 85 for light traffic streets* depending upon the sand and asphalt used and the *local climatic conditions.*

c. It shall not flash below *350* degrees F. when tested in a closed oil tester.

d. When *twenty (20) grams of the asphalt cement are heated for five (5) hours at 325 degrees F. in a tin box two and one-quarter (2¼) inches in diameter and three-quarters (¾) of an inch deep, after the manner officially prescribed, the loss shall not exceed five (5) per cent. by weight* and the penetration at 77 degrees F. of the residue left after such heating must not be less than one-half the penetration at 77 degrees F. of the original sample before heating.

e. *Either* the asphalt cement *or its pure bitumen when* made into a briquette *(Dow mold)* shall, *at 50 penetration (77*

degrees F.), have a ductility of not less than *30* centimeters at 77 degrees F.; the two ends of the briquette to be pulled apart at the uniform rate of 5 centimeters per minute.

When the asphalt cement as used has a penetration *other* than 50 at 77 degrees F., an increased ductility of 2 centimeters *will* be required for every five points in penetration above 50 penetration *and a corresponding allowance will be made below 50 penetration.*

BINDER.

11. *Preparation*—The binder shall be composed of stone, *or stone and sand,* and asphalt cement of the character elsewhere herein specified and mixed in proper proportions. The stone, *or stone and sand,* and the asphalt cement shall be heated separately to such a temperature as will give, after mixing, a binder mixture of the proper temperature for the materials employed. The stone when used must be at a temperature between *225* and 350 degrees F. The asphalt cement and stone shall be thoroughly mixed by machinery until a homogeneous mixture is produced in which all the particles are thoroughly coated with asphalt cement.

12. *Laying*—The binder mixture prepared in the manner above described shall be brought to the *work* in wagons *covered with canvas or other suitable material and upon reaching the street shall have* a temperature between 200 degrees F. and 325 degrees F. The temperature of the binder mixture within these limits shall be regulated according to the temperature of the atmosphere and the working of the binder. On reaching the street it shall at once be dumped on the concrete and then be deposited roughly in place by means of hot shovels, after which it shall be uniformly spread by means of hot iron rakes and then at once be thoroughly compacted by tamping or rolling. The *thickness* of the finished binder shall *average ... inches and not more than a forty (40) per cent. variation from the average thickness specified will be permitted at any one spot.* The upper surface *of the finished binder*

shall be parallel to the *established grade for the finished pavement.* The surface after compression shall show at no place an excess of asphalt cement and any spot showing such excess shall be cut out and replaced with other material. All binder that shows lack of bond or that is in any way defective or which may become broken up before it is covered with wearing surface must be taken up and removed from the street and replaced by good material properly made and laid in accordance with these specifications, at the expense of the Contractor. No more binder shall be laid at any one time than can be covered by *one* day's run of the paving plant on surface mixture. Binder when laid shall be followed and covered with wearing surface as soon as is practicable in order to effect the most thorough bond between the binder and the wearing course. The binder course shall be kept as clean and as free from traffic as is possible under working conditions. If necessary, it must be swept off immediately before laying the wearing surface on it.

No binder shall be laid when in the opinion of the Engineer the weather conditions are unsuitable or unless the concrete on which it is to be laid is *free from pools of water* and has set a sufficient length of time.

13. *Requirements*—The finished binder must contain *four (4) to seven* (7) per cent. of bitumen soluble in cold carbon disulphide, from fifteen (15) to thirty (30) per cent. of material passing a 10 mesh screen, *and from twenty (20) to fifty (50) per cent. of material passing a one-half (1-2) inch screen,* the percentage of bitumen to be regulated in accordance with the mesh composition and character of the mineral aggregate of the binder and the percentage of material passing a 10 mesh screen to be regulated in accordance with the traffic conditions upon the street or streets to be paved.

Wearing Surface.

14. *Preparation*—The wearing surface shall be composed of sand, filler and asphalt cement of the character elsewhere

herein specified and mixed in proper *and definite* proportions *by weight.* The sand and the asphalt cement shall be heated separately to such a temperature as will give, after mixing, a surface mixture of the proper temperature for the materials employed. The sand when used must be at a temperature between *275* and 375 degrees F. The asphalt cement when used must be at a temperature between 250 degrees F. and 350 degrees F. *The various ingredients shall be brought together and mixed* for at least one minute in a suitable apparatus until a homogeneous mixture is produced in which all the particles are thoroughly coated with asphalt cement. The weights of all materials entering into the composition of the wearing surface shall be verified in the presence of inspectors as often as may be required and the Engineer or his representatives shall have access to all parts of the plant at any time. 400

15. *Laying*—The surface mixture prepared in the manner above described shall be brought to the *work* in wagons *covered with canvas or other suitable material and upon reaching the street shall have* a temperature between 230 degrees F. and 350 degrees F. The temperature of the surface mixture within these limits shall be regulated according to the temperature of the atmosphere and the working of the mixture and the character of the materials employed. On reaching the street, it shall at once be dumped on a spot outside of the space on which it is to be spread. It shall then be deposited roughly in place by means of hot shovels, after which it shall be uniformly spread by means of hot iron rakes in such a manner that after having received its final compression by rolling, the finished pavement shall conform to the established grade. *The thickness of the finished surface mixture shall average . . . inches. Not more than a ten (10) per cent. variation from the average thickness specified will be permitted in any one spot.* Before the surface mixture is placed, all contact surfaces of curbs, manholes, etc., must be well painted with hot asphalt cement. After raking, the surface mixture shall at once be compressed

by rolling or tamping, after which a small amount of cement shall be swept over it and it shall then be thoroughly compressed by a steam roller weighing not less than two hundred (200) pounds to the inch width of tread, the rolling being *carried on continuously at the rate of not more than two hundred (200) square yards per hour per roller,* until a compression is obtained which is satisfactory to the Engineer. Such portions of the completed pavement as are defective in finish, compression or composition, or that do not comply in all respects with the requirements of these specifications, shall be taken up, removed and replaced with suitable material, properly *made and* laid in accordance with these specifications at the expense of the Contractor. Whenever so ordered by the Engineer, a space of twelve (12) inches next to the curb shall be coated with hot asphalt cement, which shall be ironed into the pavement with hot smoothing irons.

No wearing surface shall be laid when in the opinion of the Engineer the weather conditions are unsuitable or unless the binder on which it is to be placed is dry. *Excessive use of water on the steam roller when compressing the pavement will not be permitted.* The finished pavement must be well protected from all traffic by suitable barricades until it is in proper condition for use.

16. *Requirements*—The finished pavement shall *show upon analysis a mesh composition and bitumen contents within the following limits (sieves to be used in the order named):*

Bitumen	9.5 to *13.5%*	
Passing 200 mesh... Not less than	10%	Total passing 200, 100 and 80 mesh. Not less than....25%
Passing 80 mesh	*10 to 35%*	
Passing 50 mesh	*4 to 35%*	*Total passing 50 and 40 mesh........15 to 50%*
Passing 40 mesh	*4 to 25%*	
Passing 30 mesh	*4 to 20%*	*Total passing 30, 20 and 10 mesh.....10 to 35%*
Passing 20 mesh	*4 to 12%*	
Passing 10 mesh	*2 to 8%*	
Passing 8 mesh	*0 to 5%*	

The minimum amount of bitumen shall be used only in mixtures containing the minimum total passing the 80 mesh. The percentage of bitumen must be increased above the minimum as the total passing the 80 mesh increases. On streets

of *very* light traffic, when the Engineer has approved the use of a coarser sand or mixture than that specified for general use, the surface mixture must contain not less than six (6) per cent. of mineral matter passing a 200 mesh sieve and not less than a combined total of eighteen (18) per cent. passing the 200, 100 and 80 mesh sieves. The maximum amount of 200, 100 and 80 mesh material will be regulated according to the kind of sand and asphalt used and the traffic upon the street on which the pavement is to be laid, subject to the maximum requirements elsewhere herein specified under sand and filler.

The above limits as to mesh composition and per cent. of bitumen are intended to provide for such permissible variations as may be rendered necessary by the raw materials used and by the character of the work to be done. The composition of the wearing surface may be varied within the limits above specified at the discretion of the Engineer, depending upon the kind of sand, filler and asphalt used and the traffic conditions upon the street or streets to be paved.

Condition at Expiration of Guarantee.

17. In addition to the proper maintenance of the pavement during the period of guarantee, the Contractor shall, at his own expense, just before the expiration of the guarantee period, make such repairs as may be necessary to produce a pavement which shall:

a. Have a contour *substantially conforming to that of the pavement as first laid and* free from depressions of any kind exceeding three-eighths (⅜) of an inch in depth as measured between any two points four (4) feet apart on a line conforming substantially to the original contour of the street.

b. Be free from cracks *or depressions* showing disintegration of the surface mixture.

c. Contain no disintegrated surface mixture.

d. Not have been reduced in thickness more than three-eighths of an inch in any part.

e. Have a foundation free from such cracks or defects as will cause disintegration or settling of the pavement or impair its usefulness as a roadway.

Repairing.

18. Repairs, except as provided for below, shall in all cases be made by cutting out the defective binder and wearing surface down to the concrete and replacing them by new and freshly prepared binder and wearing surface made and laid in strict accordance with these specifications.

Whenever any defects are caused by the failure of the foundation, the pavement, including such foundation, shall be taken up and relaid with freshly prepared material made and laid in strict accordance with these specifications.

In all cases the surface of the finished repair shall be at the grade of the adjoining pavement and in accordance with the contour of the street.

The surface heater method of repairing may be used only in those cases where the repairs are not rendered necessary by:

a. Failure of concrete.

b. Failure of the binder.

c. Failure caused by the disintegration of the lower portion of the wearing surface.

Whenever the surface heater method is employed, all defective surface shall be removed before replacing it with new material. In all cases the old surface shall be removed to a depth of not less than one-quarter inch and the new surface must, when compressed, be not less than one-half inch in thickness. The heat shall be applied in such a manner as not to injure the remaining pavement. All burnt and loose material shall at once be completely removed and, while the remaining portion of the old pavement is still warm, shall be replaced by new and freshly prepared wearing surface made and laid in strict accordance with these specifications.

19. NOTE TO ENGINEERS—*Filler*—As Portland cement is more expensive than lime dust, the specification should distinctly state which kind of filler is desired.

Binder—The following clause has been suggested as being descriptive of the practice in some cities. The committee, however, does not feel like recommending it in a general specification. If this clause is incorporated in the specifications it should be clearly stated whether or not the practice described therein will be permitted by the City Engineer.

With the permission of the City Engineer not to exceed twenty (20) per cent. of crushed old asphalt surface mixture of suitable character may be used in combination with the binder stone, provided that such mixture produces a binder complying in all respects with the requirements of these specifications.

METHODS FOR TESTING AND SAMPLING.

The following methods are recommended as being sufficiently accurate for general use. In cases of dispute the standard methods adopted by the American Society for Testing Materials must be employed.

PENETRATION TEST.

20. Penetrations shall be taken by means of a penetrometer, which shall be so constructed as to correctly register in one-hundredths of a centimeter the depth to which a Robert's Sharps No. 2 needle will penetrate the sample under examination under a given load without appreciable retarding friction for a given time period.

For penetrations at 77 degrees F. the time period shall be five (5) seconds and the total weight operating on the needle shall be one hundred (100) grams except in the case of flux where the time period is one (1) second and the total weight fifty (50) grams.

The samples to be tested should preferably be in circular tin boxes about two and one-quarter (2¼) inches in diameter and about three-quarters (¾) of an inch deep (2 ounce Gill style can, obtainable from the American Can Company). Where very soft materials are to be tested or penetrations

are to be taken at 100 degrees F. or 115 degrees F., a tin not less than two (2) inches deep and having the same diameter specified above should be used to prevent the needle from striking the bottom of the tin before it has penetrated the sample to the full depth.

All samples shall be melted at a temperature just high enough to render them liquid (250 to 300 degrees F.) and should then be thoroughly stirred until homogeneous and free from air bubbles. After cooling sufficiently in the air at laboratory temperature they must be immersed for at least thirty (30) minutes in water maintained at the temperature at which the test is to be made (77 degrees F.). During testing the sample shall be accurately maintained at the temperature specified.

The average of from three (3) to five (5) tests which must not differ more than five (5) points (five-hundredths (0.05) of a centimeter) between maximum and minimum shall be taken as the penetration of the sample, the needle being wiped off with a dry cloth after every determination.

Remarks—This test measures the consistency of the material under examination. The limits of accuracy of this test may be considered as being within five (5) per cent. of the reading obtained (above or below).

Ductility Test.

21. This test is usually first made on the asphalt cement itself. If this fails to show the required ductility, the pure bitumen must be extracted and tested. The proper methods for obtaining the pure bitumen vary with the asphalt being examined and are too lengthy for description here. (See proceedings of American Society for Testing Materials, Vol. 9, pages 594-9.)

Preparation of Briquette—The molding of the briquette may be done as follows:

The mold should be placed upon a brass plate. To prevent the asphalt from adhering to the plate and the inner

side of the two removable pieces of the mold, they should be well amalgamated. The different pieces of the mold should be held together in a clamp or by means of an India rubber band. The material to be tested is poured into the mold while in a molten state, a slight excess being added to allow for shrinkage on cooling. After the briquette is nearly cool, it is smoothed off level by means of a heated palette knife. When cooled, the clamp is taken off and the two side pieces removed, leaving the briquette of asphalt firmly attached to the two ends of the mold, which thus serve as clips. The briquette should be immersed in water maintained at the required temperature for at least thirty (30) minutes or until the whole mass of bitumen is at 77 degrees F. It is then pulled apart at the required rate of speed in a suitable machine, the briquette being entirely immersed in water maintained at 77 degrees F. during the entire operation of pulling. Any pieces of dirt, wood, or extraneous matter in the briquette may cause the fracture of the fine thread before the true maximum ductility of the material under examination has been reached. Great care should be observed, therefore, to avoid the presence of such foreign matter in the bitumen when it is poured into the mold. The average of at least two tests shall be recorded as the ductility of the sample under examination. These tests must not differ more than twenty (20) per cent. from their average.

Remarks—This test measures approximately the cementing value of a bitumen, but is not necessarily a measure of the relative cementing value of different bituminous materials or the same bituminous material at different penetrations. The limits of accuracy of this test may be considered as being within twenty (20) per cent. of the reading obtained (above or below).

Determination of Total Bitumen In Refined Asphalts and Asphalt Cements.

22. One to two grams of the sample shall be weighed into a tared 200 c. c. wide-mouth Erlenmeyer flask and covered

with 100 c. c. of chemically pure carbon disulphide. Agitate until all lumps disappear and nothing adheres to the bottom of the flask. Cork and allow to stand fifteen (15) minutes. Filter off on a Gooch crucible with asbestos felt or a weighed filter paper and wash until the washings come through practically colorless. Dry the flask and filter at 250 degrees F. Evaporate the filtrate containing the bitumen, burn to an ash and add to the residue on the filter.

Remarks—The limits of accuracy of this test as applied to bitumens containing considerable proportions of non-bituminous matter may be considered as being within one-half per cent. above or below the result obtained. In practically pure bitumens one-quarter (¼) per cent. above or below is the ordinary limit of accuracy.

Determination of Bitumen Soluble In Carbon Tetra-Chloride.

23. One gram of the sample shall be weighed into a tared 200 c. c. wide mouth Erlenmeyer flask and covered with 100 c. c. of chemically pure carbon tetra-chloride. Agitate until all lumps disappear and nothing adheres to the bottom of the flask. Cork and allow to stand eighteen (18) hours in the dark. Filter off on a Gooch crucible with asbestos felt or a weighed filter paper and wash until the washings come through practically colorless using not less than 100 c. c. of fresh solvent. Dry the filter at 250 degrees F.

Remarks—The amount of bitumen insoluble in carbon tetrachloride is indicative of whether or not decomposition has been produced by improper heat treatment. The limits of accuracy of this test may be considered as being within one-half (½) per cent. above or below the result obtained.

Volatilization Test.

24. Twenty (20) grams of the sample shall be placed in a weighed tin box two and one-quarter inches in diameter and three-quarters of an inch high (two ounce Gill style can, ob-

tainable from the American Can Company) and heated five (5) hours at 325 degrees F. The heating shall be done in a ventilated oven which shall have reached the temperature specified before the introduction of the samples and which is maintained within two (2) degrees of that temperature throughout the test. The tin can should be insulated by a sheet of asbestos or other material from direct metallic contact with the sides or walls of the oven. The bulb of the thermometer should be immersed in a control bath immediately alongside of the sample being tested, the container and the method of insulation being the same in both cases.

Remarks—This test indicates the extent to which bitumens in the course of time lose their more volatile hydro-carbon constituents and the hardening resulting from volatilization and chemical change. It may be considered as an accelerated exposure test. The limits of accuracy of this test cannot be definitely stated owing to the widely varying results obtained by the use of different types of ovens and failure to carefully observe all the conditions prescribed. When carefully conducted according to the above directions a test showing six (6) per cent. loss should be considered as passing a specification calling for not over five (5) per cent. loss.

Flash Test.

25. Flash test shall be made in a circular tin can about two and one-quarter (2¼) inches in diameter and about one and three-eighths (1⅜) inches deep, (3 ounce Gill style, American Can Company), provided with a suitable transparent cover of mica, or glass, etc. This cover shall be provided with two apertures for the insertion of the thermometer and test flame. The aperture for the thermometer shall be three-eighths (⅜) of an inch in diameter and shall be centrally located. The aperture for the test flame shall be triangular in shape measuring one-half (½) inch on the base and three quarters of an inch in height. The base shall coincide with the rim of the can. A thermometer approximately fifteen (15) inches

long, graduated in single degrees shall have its bulb completely immersed in the material being tested. It shall not touch the bottom of the can and shall be suspended in the proper position. The can shall be filled with the material to be tested so as to leave a one-half (½) inch vapor space when melted. The material shall be heated at the rate of ten degrees F. a minute and the test flame applied every five degrees F. after a temperature of 300 degrees F. has been reached. No correction for emergent stem shall be made. The test flame shall be one-eighth (⅛) of an inch long and shall be dipped in just below the surface of the cover and then immediately withdrawn.

Remarks—This test indicates the temperature at which inflammable vapors are given off in an enclosed space. It supplements the volatilization test and guards against the use of a material containing too large an amount of volatile hydrocarbons. The limit of accuracy of this test may be considered as being five (5) degrees above or below the reading obtained.

Specific Gravity Test.

26. a. Fluid Materials:

The specific gravity of fluid materials shall be taken in the usual way in a picnometer at 77 degrees F.

b. Viscous Fluid and Semi-Solid Materials:

The specific gravity of these materials shall be taken in a cylindrical weighing bottle picnometer as given on page 10, bulletin No. 38 of the Office of Public Roads.

c. Hard Solid Materials:

The specific gravity of hard, solid materials shall be taken by the displacement method.

Determination of Bitumen Contents and Mesh Composition of Binder.

27. Weigh out from 350 to 500 grams of the binder and extract the bitumen from it in a centrifugal extractor or suitable continuous hot extractor using chemically pure car-

bon disulphide as a solvent for the bitumen. Follow the same general method for the drying and sifting of the mineral aggregate as described in the method for analyzing surface mixtures. The sieves to be used are as follows:

1¼-inch, 1-inch, ¾-inch and ½-inch circular openings, and 10-mesh.

Remarks—The limits of accuracy of this test are as follows:

For bitumen contents, three-tenths (0.3) per cent. above or below the result obtained. For mesh composition, ten (10) per cent. of the result obtained (above or below).

Determination of Bitumen Contents and Mesh Composition of Surface Mixtures.

28. The sample of surface mixture should be heated to about 300 degrees F. until soft and ten to twenty grams of it weighed on to a tared S. & S. filter paper No. 595, 11 cms. in diameter. The filter paper and contents should be placed in a funnel and washed with chemically pure carbon disulphide until the washings run through practically colorless. Dry the filter paper and residue at 250 degrees F. for one-half (½) hour. Open the filter paper carefully and remove the mineral aggregate. Scrape off the dust adhering to the paper as thoroughly as possible with a blunt palette knife and add it to the mineral aggregate. Evaporate the filtrate containing the bitumen, burn the bitumen, add the filter paper to it and burn to an ash. Add the ash to the mineral aggregate previously removed from the filter paper and weigh. The difference between the weight of surface mixture originally taken and the combined weight of the ash and residue is considered as the weight of bitumen in the sample. The combined ash and residue is then sifted through the following sieves (in the order named) and the percentages of the various sized particles calculated:

200, 100, 80, 50, 40, 30, 20, 10 and 8.

Sifting shall be continued on each sieve until less than one (1) per cent. passes through the sieve during the last minute of sifting.

If desired, the surface mixture may be extracted in a centrifuge or in any suitable form of extractor with hot chemically pure carbon disulphide and the combined ash from the extracted bitumen and the mineral aggregate sifted as above.

Remarks—The limits of accuracy of this test are as follows:

For bitumen contents, three-tenths (0.3) per cent. above or below the result obtained. For mesh composition, ten (10) per cent. of the result obtained (above or below).

Samples.

29. Samples should be put in clean, dry containers, preferably tin boxes or cans. The following amounts of the different materials are required for test:

Binder stone	5 pounds
Filler	½ pound
Sand	1 pound
Refined asphalt	1 pound
Asphalt cement	1 pound
Flux	1 pound

Method of Sampling—Extreme care should be taken in every case to obtain a sample which is truly representative of the material to be examined. The particular precautions to be observed in each case are given below:

Binder Stone—A sufficient number of five-pound samples to be taken from different parts of the pile. These should be thoroughly mixed together and reduced by quartering to the desired size.

Filler—A sample should be taken from several bags and mixed.

Sand—Samples should be taken from the interior of the pile where the sand is damp. A sufficient number of one pound samples to be taken from different parts of the pile. These should be thoroughly mixed together and reduced by quartering to the desired size.

REFINED ASPHALT AND ASPHALT CEMENT.

30. In barrels:

At least one sample should be taken from each batch. It should be taken at sufficient depth below the surface to insure obtaining representative material free from all dirt or other extraneous matter.

In tank cars:

The contents of the tank should be heated until completely liquid throughout. It should then be agitated and thoroughly mixed by means of air or steam, after which the sample may be taken in any convenient manner.

In kettles:

The contents of the kettles must be completely liquid and thoroughly agitated previous to and during sampling. The sample may be taken from the pipe through which the material is delivered to the mixer or by means of a clean dipper.

31. *Flux*—The directions given for sampling refined asphalt and asphalt cement apply to this material except that under ordinary conditions it is not necessary to agitate the contents of the tank car.

32. *Surface and Binder Mixtures*—Samples should preferably be taken on the street after the mixture has been shoveled and raked. Samples taken from the plant shall be obtained from the wagons, special care being observed to avoid material from the top of the load or which appears to vary from the average. Samples should be pressed between a sheet of paper and trimmed while hot to a convenient size.

REPORT OF SUB-COMMITTEE ON SPECIFICATIONS FOR SEWER CONSTRUCTION.

The Sub-Committee on Standard Specifications for Sewer Construction presents herewith its report of progress during the year that elapsed since the last annual convention. This report is in the form of a complete specification which has been corrected and revised in accordance with the wishes of the full committee as expressed at the last convention and with our own ideas as to the form such a specification should take and the requirements which it should contain.

It is not submitted with the expectation that in all its details it will meet the ideas of all officials and engineers, or that its requirements will satisfy conditions which must be met in widely separated localities or under all conditions and forms of municipal government. It is manifestly impossible to make a specification broad enough and at the same time sufficiently concise to do this.

We have not attempted to make it a book of rules which covers all contingencies and which, without careful consideration of the circumstances and conditions in each case, can be used indiscriminately, by those unfamiliar with work of this character and without ability to properly interpret its requirements, with assurance that satisfactory results will be obtained. No matter how perfect such a specification may be, satisfactory results can never be obtained without intelligent engineering supervision: first, to carefully adapt the standard to the conditions in the particular locality; second, to correctly interpret its provisions as they apply to the particular contract in hand; and, third, to honestly and impartially, as between the city and the contractor, enforce these provisions in the execution of the contract.

We have endeavored to set forth all of the requirements for satisfactory work of this character under all ordinary con-

ditions in complete form, and to arrange these requirements in logical order for easy reference and interpretation.

The special requirements of work of magnitude will usually require addenda to the specification to cover its special features and considerations of economy, and expediency will frequently require the modification of figures or other definite requirements contained therein to meet special conditions, but on the whole and for the great majority of standard work we believe this specification as now presented will, if properly applied, insure good, permanent work, quite equal to the best modern practice.

In tentative though substantially the same form the specification has been presented to and published by this Society in the Proceedings of its last two annual conventions. On the occasions of these conventions criticism and discussion were invited by your committee with the idea of obtaining as far as possible the concensus of opinion of engineers as to the various requirements incorporated in it.

The general form of the specification has not, so far as we know, met with any criticism. Certain specific requirements have been debated, but the total amount of discussion and debate elicited has been disappointingly small.

After three years of labor in producing this specification, which in all its essential features we believe embodies all the requirements necessary for thoroughly first-class sewer construction, your committee respectfully requests that it be considered for final adoption by the Society at this convention.

We realize that our work is not absolutely perfect, that no perfect specification has ever been written, and that it should be subjected to frequent revision in order to keep pace with the constant advance in the science of sewer design and construction, but we have not in mind at the present time any changes in or additions to it which could be advantageously made.

Respectfully submitted,

E. J. Fort,

Rudolph Hering,

Committee.

SPECIFICATIONS FOR SEWER CONSTRUCTION.

Adopted October 8, 1914.

NOTE—These specifications will be modified from time to time to keep them fully up to date. Suggestions as to modifications or additions are solicited and should be sent to the Secretary, or to E. J. Fort, Municipal Building, Brooklyn, N. Y., Chairman of the Sub-Committee on Specifications for Sewers, and George W. Tillson, Boro Hall, Brooklyn, N. Y., Chairman of the General Committee on Standard Specifications.

TRENCHES.

LENGTH OF TRENCH.

1. Unless otherwise directed or permitted not more than ... feet of any trench in advance of the end of the built sewer shall be open at any time; and unless written permission to the contrary is given, the trench shall be excavated to its full depth for a distance of at least ... feet more than the minimum length of sewer permitted to be laid in it (see sections 152 and 158). Trenches for house connection drains shall not be open on both sides of the street at the same time, unless permission has previously been given to close the street. Unless otherwise directed, each trench for basin connections and house connection drains shall be fully excavated for its entire length before any pipes are laid therein.

SHEETING AND BRACING.

2. Where necessary, the sides of the trenches and excavations shall be supported by adequate sheeting and bracing. Steel sheeting may be used only where shown on the plan or directed. Sheeting and bracing will be paid for only when left in place by written order, in which event the amount left in place will be paid for at the contract price for such material. Unless specially permitted, sheeting against which concrete is placed shall not be removed, but such sheeting will not be paid for unless ordered to be left in place to protect

the sides of the trenches and excavations. The Contractor will be held accountable and responsible for the sufficiency of all sheeting and bracing used, and for all damage to persons or property resulting from the improper quality, strength, placing, maintaining or removing of the same.

Sheeting In Soft Material.

3. Where the material to be excavated is of such a character or other conditions are such as to render it necessary, the sheeting shall be closely driven and to such depth below the bottom of the sewer as may be directed.

Tunneling.

4. All work shall be done in open trenches or excavations, no tunneling shall be done except with the consent of the Engineer.

Trees and Stumps.

5. The Contractor shall grub and clear the surface over the trenches, and the excavations of all trees, stumps, stones and any other incumbrances affecting the prosecution of the work, and shall remove them from the site.

Material To Be Disinfected.

6. If required by the Engineer, any or all of the excavated material shall be satisfactorily disinfected or deodorized or immediately removed from the work.

Roadway, Sidewalks, Etc., To Be Kept Clear.

7. Unless permission is given to the contrary, the excavated material and materials of construction shall be so deposited, and the work shall be so conducted as to leave open and free for pedestrian traffic all crosswalks, a space on each sidewalk not less than one-third the width of the sidewalk and not less than 3 feet in width, and for vehicular traffic a roadway not less than 8 feet in width. All street hydrants, water gates, fire alarm boxes and letter boxes shall be kept accessible for

use.. Not more than ... linear feet of sidewalk shall be used at any time for storage of materials from any one trench. During the progress of the work the Contractor shall maintain such crosswalks, sidewalks and roadways in satisfactory condition, and the work shall at all times be so conducted as to cause a minimum of inconvenience to public travel, and to permit safe and convenient access to private and public property along the line of the work.

Surplus Material.

8. If all of the excavated material cannot be stored on the street in such a manner as to maintain the traffic conditions hereinbefore specified, the surplus shall be removed from the work and stored. After the construction of the sewer, so much of this material as is of satisfactory quality and necessary for the purpose shall be brought back and used for backfilling the trench.

Material from first ... feet to be carted away.

9. Where directed, in built-up districts and in streets where traffic conditions render it necessary, the material excavated from the first ... feet of trenches shall be removed by the Contractor as soon as excavated, and the material subsequently excavated, if suitable for the purpose, shall be used to backfill the trenches in which the sewers have been built and neither the excavated material nor materials of construction shall be stored on the roadways or sidewalks.

Fence.

10. Where required by the Engineer, suitable fences shall be placed along the sides of the trenches to keep the streets safe for traffic.

Temporary Bridges.

11. Crosswalks, where intersected by trenches, shall if required be temporarily replaced by substantial timber bridges not less than 3 feet wide, with side railings. Where required, suitable temporary bridges for vehicles shall be provided and maintained across trenches.

Disposal of Water From Trenches.

12. The Contractor shall at all times during the progress of the work keep the trenches and excavations free from water. Water from the trenches and excavations shall be disposed of in such a manner as will neither cause injury to the public health, nor to public or private property, nor to the work completed or in progress, nor to the surface of the streets, nor cause any interference with the use of the same by the public.

Cost To Be Covered.

13. The cost of all labor required to be done and all materials required to be furnished in the performance of all of the work specified in paragraphs 1 to 12, inclusive, except as otherwise provided, shall be covered by all the contract prices for all the items for which there are contract prices.

EARTH EXCAVATION.

14. Earth excavation shall include the removal of all material other than rock as defined in sections 21 and 22.

Width of Trench For Sewers, Etc.

15. The minimum widths of trenches in earth for pipe sewers, basin connections, house connection and other drains not over 18 inches in diameter, shall be such as to give a clearance of 8 inches on each side of the barrel of the pipe, and for those of larger diameters, of 10 inches on each side of the barrel of the pipe, and all such trenches shall have a clear width equal to the maximum widths of the cradles of the sewers to be laid in them, when such cradles are wider than the minimum widths hereinbefore specified. The minimum clear widths of trenches in earth for other sewers shall be the greatest external width of the structures, including the necessary forms, to be built therein.

Excavation For Manholes, Etc.

16. Where a riser, manhole or other appurtenance or the foundation therefor extends beyond the exterior lines of the sewer or its foundation, the minimum excavation in earth required for the same shall be that contained in a prism with vertical sides and a horizontal section equal to the smallest rectangle which will enclose such appurtenance and its foundation.

Excavation For Receiving Basins, Etc.

17. The minimum dimensions of the excavation in earth for brick receiving basins, catchbasins and flush tanks shall be such as to give a clearance inside the sheeting of 1 foot on all sides above the foundation, but in all such cases the excavation shall be large enough to include the foundation for the structures shown on the plan. The excavation for concrete catch basins and flush tanks shall be of such dimensions as to permit the proper placing and removal of the necessary forms.

Depth of Trenches.

18. Trenches shall be excavated to the depths required for the foundations of the sewers and appurtenances shown on the plan, and where conditions are such as to make it necessary, to such additional depths as may be directed. Where pipe is laid without a cradle, the bottoms of trenches shall be excavated to fit the lower third of the pipe, and excavations shall be made to receive the hubs. All irregularities in the bottoms of trenches shall be filled up to the required grade with suitable material.

Cost To Be Covered.

19. The cost of all labor required to be done and all materials required to be furnished in the performance of all the work specified in paragraphs 14 to 18, inclusive, except as otherwise provided, shall be covered by all the contract prices for all the items for which there are contract prices.

Additional Earth Excavations.

20. When there is a contract price for additional earth excavation, it shall cover the cost of excavating all material (other than rock) ordered to be excavated beyond the lines and depths herein specified in sections 15 to 18, inclusive, and also the cost of excavating all material within the lines of the trenches above the surface of the ground as shown on the plan, when such material has not been placed there by the Contractor. This contract price shall also cover the cost of filling such excavations with approved material. Where no price is named in the contract for additional earth excavation, the cost of the several items enumerated above shall be covered by all the contract prices for all the items for which there are contract prices.

ROCK EXCAVATION.

Definition.

21. Rock excavation shall include the excavation and removal of the following materials:

a. Rock which shall be determined to be of such a character as to warrant its removal by blasting, in order to insure the prompt and proper prosecution of the work.

b. Boulders and pieces of rock, masonry in mortar, and concrete, each of which contains one-third cubic yard or more, except the masonry and concrete of old sewers and their appurtenances.

22. Pieces of rock, masonry, concrete or boulders which fall or slide into the trench from beyond the lines thereof as herein defined, will not be measured, and the cost of the removal of the same shall be covered by all the contract prices for all the items for which there are contract prices.

Width of Trench.

23. The required width of trench in rock for pipe sewers, basin connections, house connections and other pipes will

be such as to give a clearance of one foot on each side of the pipe, exclusive of spurs and hubs, the required width of trench in rock for other sewers and drains will be such as to give a clearance of one foot on each side of the structure to be built therein at its greatest external width. Where a riser, manhole or other appurtenance, or the foundation therefor, extends beyond the exterior lines of the sewer or its foundation, the excavation in rock required for the same will be that contained in a prism with vertical sides and a horizontal section one foot wider on each side than the smallest rectangle which will enclose such appurtenance and its foundation. The required dimensions of the excavation in rock for receiving basins, catch basins and flush tanks will be such as to give a clearance of one foot on all sides above their foundations.

Depth of Trench.

24. The rock shall be excavated to the depths required for the cradles and foundations of the structures as shown on the plan, and not less than 4" below the outside of the barrel for the pipe sewers.

Measurement.

25. The volume of rock to be paid for will be that contained in prisms with vertical sides and of such dimensions as to give the widths and clearances hereinbefore specified from the bottoms of the trenches, as specified and as shown on the plan to the surface of the rock.

Rock Stripped.

26. Rock shall be stripped in sections, which unless otherwise permitted, shall be not less than 50 feet in length, and the Engineer shall then be notified in order that he may measure the same. Rock excavated or blasted before such measurement is made will not be paid for.

Excavation For Branches.

27. Wherever a branch for a proposed sewer or extension of a sewer is built in rock, the required trench shall be ex-

cavated for a distance of not less than 5 feet beyond the end of such branch, in the direction of the proposed sewer or extension.

BLASTING.

28. All blasting operations shall be conducted in strict accordance with existing ordinances and regulations relative to rock blasting and the storage and use of explosives. Any rock excavation within 5 feet of a water main less than 36 inches in diameter, and within 10 feet of a water main 36 inches or more in diameter, shall be done with very light charges of explosives, or, if directed, without blasting, and the utmost care shall be used to avoid breaking or disturbing the main.

EXPOSED STRUCTURE TO BE PROTECTED.

29. All exposed sewers, manholes, receiving basins and other structures shall be carefully protected from the effects of blasts. Any damage done to such structures shall be promptly repaired by the Contractor at his own expense.

PRICE TO COVER.

30. The contract price for rock excavation shall cover the cost of all labor and materials required to excavate and remove all rock as specified, and without regard to its subsequent use. When there is no contract price for rock excavation the cost of excavating and removing rock shall be covered by all the contract prices for all the items for which there are contract prices.

BACKFILLING.

BACKFILLING AROUND SEWERS, ETC.

31. Unless otherwise specified or directed, all trenches and excavations shall be backfilled immediately after the structures are built therein. For a depth of at least 2 feet over the top of sewers, basin connections, house connections and other

drains, the material used for backfilling trenches as excavated shall be clean earth, sand or rock dust. It shall be carefully deposited in uniform layers not exceeding 6 inches in depth, and unless otherwise permitted each layer, shall be carefully and solidly tamped with appropriate tools in such a manner as to avoid injuring or disturbing the completed work.

Backfilling For Remainder of Trench.

32. Backfilling for the remainder of the trenches as excavated shall be approved material free from organic matter and containing no stones over 10 inches in their largest dimensions. Stones which are used in backfilling shall be so distributed through the mass that all interstices are filled with fine material. Backfilling shall be deposited as directed, and unless otherwise permitted shall be spread in layers and solidly tamped.

Backfilling Around Manholes, Receiving Basins, Etc.

33. Backfilling within 2 feet of manholes, house connection drains, receiving basins, inlet basins, flush tanks and other structures shall be of the same quality as that specified in sections 31 and 32. It shall be uniformly deposited on all sides and unless otherwise permitted solidly tamped in such a manner as to avoid injuring the structures or producing unequal pressures thereon.

Puddling.

34. Backfilling shall, if required, be flooded or puddled with water as the work progresses, instead of being tamped.

Cavities Filled.

35. When sheeting is drawn, all cavities remaining in or adjoining the trench shall be solidly filled. When sheeting is left in place, all cavities behind such sheeting shall be solidlly filled as directed.

Deficiency of Filling.

36. Unless otherwise shown on the plan, trenches shall be backfilled to the height of the surface of the ground as it existed at the commencement of the work. Should there be a deficiency of proper material for the purpose, the Contractor shall furnish and place such additional material as may be required.

Temporary Bulkheads.

37. For retaining backfilling only temporary bulkheads will be allowed. Such bulkheads shall not be of stone, and they shall be removed as the trenches are backfilled.

Curves, Branches, Etc., Not To Be Covered.

38. Sewers built on curves, also drains, basin connections, house and sewer connections and intersections, ends of sewers and branches shall not be covered until the Engineer shall have inspected, measured and located the same, and given permission to backfill the trenches over them.

Removal of Surplus Material.

39. As trenches are backfilled, the Contractor shall remove all surplus material and regrade and leave free, clear and in good order all roadways and sidewalks to within ... feet of the end of the completed work. During the progress of, and until the final payment for and acceptance of, the work, he shall maintain in good and safe condition the surface of the street over all trenches, and promptly fill all depressions over and adjacent to trenches caused by settlement of backfilling. In case of failure or neglect on the part of the Contractor to comply with the requirements of this paragraph within 24 hours after the service upon him of a written notice so to do, the ... may furnish all materials and do all work required, and the cost thereof will be charged to the Contractor and deducted from any moneys due or to become due him under this contract. All surplus material or any part thereof

shall, if required, be deposited as directed on the streets and avenues within the limits of this contract where surfaces are below grade, and in such a manner as to leave the surfaces of the filled material even.

Cost Included.

40. The cost of all labor required to be done and all materials required to be furnished in the performance of all the work specified in sections 31 to 39, inclusive, shall be covered by all the prices for the items for which prices are named in the contract.

CEMENT.

Quality.

41. All cement used in the work shall be high-grade Portland cement of well-established and approved brands.

Specific Gravity; Weight.

42. The cement shall have a specific gravity of not less than 3.10 after being thoroughly dried at 212° F. It shall weigh not less than 376 pounds net, to the barrel, 4 bags of 94 pounds each being considered equivalent to a barrel. For the purpose of measurement one bag shall be considered as the equivalent of one cubic foot.

Fineness.

43. The cement shall be dry, finely ground, of uniform color and free from lumps. It shall leave a residue of not more than 8 per cent. by weight when passed through a No. 100 sieve, and not more than 25 per cent. when passed through a No. 200 sieve.

Tensile Strength.

44. Standard briquettes shall develop, within the periods specified, tensile strength not less than that shown in the following table:

NEAT CEMENT.	Lbs. per sq. in.
24 hours in moist air	175
7 days (1 day in moist air, 6 days in water)	500
28 days (1 day in moist air, 27 days in water)	600
Mortar consisting of 1 part cement and 3 parts of standard Ottawa sand, by weight.	
7 days (1 day in moist air, 6 days in water)	180
28 days (1 day in moist air, 27 days in water)	225

The average of the tensile strength developed at each age by the briquettes in any set from one sample will be considered the strength of the sample at that age, excluding any results that are manifestly faulty. The average strength of briquettes at 28 days shall be greater than the average strength at 7 days, and if tests are made after 28 days the strength shall be not less than that at 28 days.

SOUNDNESS.

45. Pats of neat cement, when tested for constancy of volume or soundness, shall remain firm and hard and show no sign of checking, cracking, distortion or disintegration.

SETTING.

46. Unless otherwise required, cement shall not develop initial set in less than 30 minutes, and shall develop final set in not less than 1 hour nor more than 10 hours. Quick-setting cement of an approved brand shall, if required, be kept on the work in sufficient quantity to provide for any contingency requiring the use of the same.

TESTING.

47. Cement will be subjected to such tests as the Engineer may deem necessary, and such tests will be made in accordance with the methods recommended by the Committee on Uniform Tests of Cement of the American Society of Civil Engineers.

RE-TESTING.

48. Any cement which shall have been kept in storage after testing for a sufficient time to warrant it, shall be re-

tested. Any prior acceptance shall be considered void and the acceptance or rejection of the cement shall depend upon the results of the latest tests.

APPROVAL OF BRAND MAY BE RESCINDED.

49. The engineer may at any time rescind the approval of any brand of cement that develops qualities which in his opinion unfit it for use in the work.

SAMPLES.

50. The contractor shall notify the engineer of the arrival of cement on the work, and furnish such facilities as may be required for obtaining samples for testing. Samples will be taken so as to fairly represent the material. The number of packages sampled and the quantity to be taken from each will depend upon the importance of the work and the number of tests to be made.

DELIVERY AND STORING.

51. Cement shall be delivered on the work in barrels or approved bags of uniform size with the brand and the name of the manufacturer plainly marked thereon, and shall be immediately stored in a dry place and carefully protected from the weather. A sufficient stock of cement shall be kept on the work in advance of the necessity for its use to permit of the making of the required seven-day tests. Except by written permission, no cement shall be used before it has been tested and accepted, and any concrete or masonry which may have been made under such permission with cement that is subsequently rejected, shall be removed and replaced with concrete or masonry made of accepted cement. All cement found to be of improper or inferior quality shall be immediately removed from the site of the work.

COST TO BE COVERED.

52. The cost of furnishing, storing and incorporating cement in the work, and the cost of samples required for testing,

shall be covered by the contract prices for the structures or classes of work in connection with which the cement it used.

MORTAR.

Composition.

53. All mortar used in the work, unless otherwise specified, shall be composed of 1 volume of cement, as in the original package, and 2 volumes of sand. Mortar used in the haunch walls of brick sewers shall be composed of 1 volume cement and 3 volumes of sand.

Sand.

54. The sand shall be clean and sharp, free from dirt, loam, mica and organic matter, and shall contain not more than 8 per cent. by volume of clay, and no clay shall be artificially added.

Mixing.

55. Mortar shall be mixed in a suitable box or on a tight platform, and never upon the ground. The cement and sand shall be thoroughly mixed dry, until the mixture has a uniform color. Clean, fresh water shall then be added and the mass worked until a mortar which is uniform and of the required consistency is produced. Mortar shall be mixed in no greater quantity than is required for the work in hand, and any that has set sufficiently to require retempering shall not be used.

Freezing Weather.

56. The mixing and use of mortar in freezing weather shall be subject to the same requirements as hereinafter specified for mixing and placing concrete under similar conditions.

Cost Covered.

57. The cost of all labor and materials required to furnish and place mortar in the work, as specified, shall be covered by the contract price for the structure or class of work in connection with which the mortar is used.

CONCRETE.

Class A Concrete.

58. Class A concrete shall be made of 1 part of cement, 2 parts of sand and 4 parts of broken stone or gravel.

Broken stone for Class A concrete shall be hard, sound and durable and shall not contain loam, clay, organic matter, objectionable quantities of dust or other improper material. Broken stone for Class A concrete shall be the run of the crusher that will pass through a screen with circular openings 1 inch, 1½ inch and 2 inches in diameter and be retained on a screen with openings ⅛ inch in diameter. Gravel shall be of hard, sound, durable material equal in quality to that specified for broken stone. It shall be clean and of the sizes herein specified for broken stone.

Class B Concrete.

59. Class B concrete shall be made of 1 part of cement, 2½ parts of sand and 5 parts of broken stone or gravel.

Broken stone, gravel and sand for Class B concrete shall in all respects comply with the requirements specified for the same materials for Class A concrete.

Class C Concrete.

60. Class C concrete shall be made of 1 part of cement, 3 parts of sand and 6 parts of broken stone or gravel. Broken stone for Class C concrete shall be the run of the crusher that will pass through a screen with circular openings 1 inch, 1½ inch and 2 inches in diameter and be retained on a screen with circular openings ⅛ inch in diameter. Gravel for Class C concrete shall be as specified for Class A concrete.

Broken stone, gravel and sand for Class C concrete shall in all respects comply with the requirements for similar materials for Class A concrete, except as to sizes as above specified.

Rubble Concrete.

61. Rubble concrete shall consist of Class B concrete with large stones embedded therein.

The embedded stones shall be hard, sound and durable, roughly cubical in shape and of such sizes as may be deemed suitable for the mass in which they are to be used. They shall be laid on their largest beds and be so placed in the work that they will not be nearer than 9 inches to the bottom of a footing, to an expansion joint, to any surface or to each other. The stones after having been thoroughly cleaned and wetted shall be firmly bedded in the concrete. The joints shall then be filled and the stones covered with concrete to such a depth that the spacing specified will be obtained. The stones shall not be placed directly on any concrete which has acquired its initial set.

Measuring Ingredients.

62. For the purpose of determining the proportions of the materials for concrete, each bag of cement will be considered as containing 1 cubic foot and the other ingredients shall be measured by an approved method.

Water.

63. Only clean, fresh water shall be used for concrete.

Mixing.

64. Unless permitted to be mixed by hand, concrete shall be mixed in approved mechanical batch mixers, so constructed and operated that the ingredients of the concrete may be accurately measured and will be thoroughly mixed. Enough water shall be added during the mixing to bring the concrete to the required consistency, which for concrete laid in place shall generally be such that the concrete may be poured into place without causing the separation of the stones from the mortar. When concrete is mixed by hand the broken stone or gravel shall be thoroughly wet before it is used. The cement and sand shall be mixed in the proper proportions dry until the mixture has a uniform color. It shall then be made into mortar of the desired consistency. The broken stone shall be added and the entire mass turned until each stone is entirely coated with mortar.

PLACING CONCRETE.

65. Concrete shall be mixed only in such quantity as is required for the work in hand, and any that has set sufficiently to require re-tempering shall not be used. Any concrete in which the water has separated from the solid matter shall be satisfactorily remixed before being placed. The concrete shall be so deposited in the work as to prevent the separation of the stone from the mortar. It shall be deposited in as nearly a continuous operation as practicable and shall be worked, tamped, spaded or rammed with suitable tools to produce a dense and compact mass. When the operation of placing concrete is interrupted the concrete in the work shall, if required, be confined by suitable temporary forms or bulkheads. When concrete is to surround re-inforcing rods, structural steel or wire netting, it shall be so deposited as to work closely around such material. When a comparatively dry concrete is used it shall be deposited in horizontal layers not exceeding 6 inches in depth and solidly tamped.

JOINING OLD AND NEW CONCRETE.

66. When fresh concrete is to be laid on or adjoining concrete already set, the surface of the latter shall be thoroughly cleaned, washed and roughened, and coated with a grout of neat cement before the fresh concrete is deposited.

FORMS AND CENTERS.

67. The Contractor shall provide all necessary forms and centers for shaping concrete. They shall be true to the required shapes and sizes, strong enough and so secured in place as to withstand all operations incidental to placing the concrete, and watertight, and the faces against which the concrete is to be placed shall be satisfactorily smooth and clean. When lumber is used in forms and centers for exposed faces it shall be of seasoned stock and shall be coated as directed with an approved lubricant.

REMOVAL OF FORMS AND CENTERS.

68. Forms and centers shall be left in place until the concrete has set sufficiently to permit their removal without danger to the structure, and until so much of the backfilling or embankment as may be directed has been put in place. No forms or centers shall be struck or removed until permission to do so has been given by the Engineer.

EXPOSED SURFACES.

69. Special care shall be used to secure smooth and uniform finish to the surfaces of concrete which will be exposed in the completed structure. Immediately after the removal of the forms such surfaces if uneven shall be rubbed smooth to a uniform and satisfactory finish. All exposed edges of concrete shall be neatly rounded as directed, and if any voids, projections or other imperfections be found, such defects shall at once be corrected by tooling, cutting out and filling with mortar, or otherwise, as directed.

EXPANSION JOINTS.

70. Expansion joints shall be provided in such manner and at such places as are shown on the plan or as may be directed. All unavoidable joints shall be made as shown on the plan or as directed.

DEPOSITING CONCRETE UNDER WATER.

71. Whenever it becomes necessary to place concrete under water, it shall be deposited by means of drop-bottom buckets, closed chutes or other approved method. Concrete so deposited shall be carefully spread without tamping.

FREEZING WEATHER.

72. In freezing weather, until the temperature falls to 24° F. the water used for concrete shall, if directed, be heated to an approved temperature, and if directed, 1 per cent. by weight of salt shall be added to the water for each degree

Fahrenheit that the temperature of the air is below 32° F. Other materials for concrete shall be heated sufficiently to remove all frost and ice. No concrete shall be laid when the temperature of the air is below 24° F.

Protection.

73. Concrete shall be allowed to set for such time as may be directed before it is worked or walked upon, or before backfilling or other material is placed upon or against it. It shall not be flooded with water until it has sufficiently set. Concrete shall be carefully protected from injury by freezing and from the drying effects of the sun and wind by covering it with canvas, bagging, hay or other suitable and approved materials. Such protection shall be placed as soon as the concrete is in condition to receive it, and except in freezing weather, the covering as well as the concrete shall be kept wet for such time as may be directed.

Measurement.

74. The amount of concrete to be paid for as such will be all concrete put in place as shown on the plan or as directed, except such concrete shown on the plan as parts of structures for which there are contract prices and the cost of which is hereinafter specified as covered by the contract prices for such structures.

Prices to Cover.

75. The contract prices for the various classes of concrete shall cover the cost of all labor and materials required to furnish, place and remove all necessary forms and centers, and to make, place, furnish and protect the concrete as specified.

BRICK MASONRY.

Quality of Bricks.

76. All bricks used in the work shall be sound and hard burned throughout and of uniform size and quality. If re-

quired, the bricks shall be culled immediately after they are brought on the work and all bricks which are warped, cracked or of improper size, shape or quality shall be at once removed. The proportion of bats permitted will be determined according to the character and location of the work in which they are to be used. When bricks are used for lining inverts and in neat arch courses of sewers they shall be specially selected and no bats shall be used except for closers.

Vitrified Bricks.

77. Where shown on the plan, vitrified bricks of approved size and quality shall be furnished and laid. After having been thoroughly dried and then immersed in water for 24 hours they shall not absorb more than 4 per cent. of their weight of water.

How Laid.

78. Bricks shall be satisfactorily wet when being laid and each brick shall be laid in mortar so as to form full bed, end and side joints in one operation. The joints shall be not wider than ⅜ inch, except when the bricks are laid radially, in which case the narrowest part of the joint shall not exceed ¼ inch. The bricks shall be laid in a workmanlike manner, true to line, and wherever practicable the joints shall be carefully struck and pointed on the inside. Brickwork shall be laid with a satisfactory bond, and as it progresses shall be racked back in courses, unless otherwise permitted.

BRICKWORK.

Protection.

79. All fresh brickwork shall be carefully protected from freezing and from the drying effects of the sun and wind, and if required, it shall be sprinkled with water at such intervals and for such a time as may be directed. Brickwork shall be protected from injuries of all sorts, and all portions which may become damaged or may be found defective shall be repaired, or if directed, removed and rebuilt.

Freezing Weather.

80. In freezing weather bricks shall be heated when directed, sufficiently to remove all ice and frost.

Measurement.

81. The amount of brick masonry to be paid for as such will be all brick masonry built, as shown on the plan or as directed, except such brick masonry shown on the plan as parts of structures for which there are contract prices and the cost of which is hereinafter specified to be covered by the contract prices for such structures.

Price To Cover.

82. The contract price for brick masonry shall cover the cost of all labor and materials required to build and protect the same as specified.

CUT STONES.

Materials.

83. Where shown on the plan, cut stones of the required kind, form, dimensions and finish, shall be furnished and accurately set in full beds of mortar. The stones shall be sound, durable and free from rifts, seams and laminations, and other imperfections.

Cost Covered.

84. The cost of all labor and materials required to furnish and set cut stones as specified shall be covered by the contract price for the structure or class of work in connection with which they are used.

CEMENTED RUBBLE MASONRY.

Materials.

85. Stones for rubble masonry shall be hard, sound, free from checks and shakes, as nearly rectangular as practicable,

and unless used for trimming or closers, not less than 6 inches thick. The stones shall be cleaned and wetted immediately before being placed in the work; they shall be laid on their natural beds, in full beds and joints of mortar, with spalls firmly embedded therein. In walls, one-third of the stones shall be headers extending through the walls where the same do not exceed 3 feet in thickness.

How Laid.

85a. All rubble masonry laid in mortar shall be laid to line, thoroughly and satisfactorily bonded, and in courses roughly levelled up. When the laying of rubble masonry in mortar is interrupted the tops of the courses shall be left unplastered. No dressing or tooling shall be done on or upon any stone after it is in place. Immediately before any rubble masonry in mortar is laid on or against any such masonry in which the mortar has set, the surface of such masonry shall be thoroughly cleaned and wetted. Rubble masonry laid in mortar shall not be laid in freezing weather.

Pointing.

86. When the faces of rubble masonry laid in mortar will be exposed to view in the finished work, the joints in such faces shall be raked out to a depth of not less than 1 inch and neatly pointed with mortar composed of 1 part cement and 2 parts sand.

Measurement.

87. The amount of rubble masonry laid in mortar to be paid for as such will be all cemented rubble masonry built as shown on the plan or as directed, except such shown on the plan as being part of structures for which there are contract prices, and the cost of which is hereinafter specified to be covered by the contract prices for such structures.

Price To Cover.

88. The contract price for cemented rubble masonry shall cover the cost of all labor and materials required to construct the same, as specified.

DRY RUBBLE MASONRY.

How Laid.

89. Dry rubble masonry shall conform to the requirements specified in sections 85 and 87, except those that relate to the use of mortar. All joints shall be thoroughly pinned and wedged with suitable spalls.

Price To Cover.

90. The contract price for dry rubble masonry shall cover the cost of all labor and materials required to construct the same, as specified.

STONE BALLAST.

Quality.

91. Stone ballast shall be broken stone, clean, sound, hard and roughly cubical in shape and unless otherwise shown on the plan or directed, of sizes ranging from 1 inch to 4 inches. Cobbles, if satisfactory, may be used.

Price To Cover.

92. The contract price for stone ballast shall cover the cost of all labor and materials required to furnish and place the same as specified.

STRUCTURAL STEEL.

Quality.

93. All structural steel used shall be medium steel for members and rivet steel for rivets made by the open hearth process and shall conform to the latest revised Standard Specifications for Structural Steel for Buildings adopted by the American Society for Testing Materials, and such tests as may be required shall be made in accordance therewith and at the places hereinafter specified. The chemical and physical properties of the steel shall be as follows:

Properties considered.	Medium Steel.	Rivet Steel.
Phosphorus (maximum)	0.06 per cent.	0.06 per cent.
Ultimate tensile strength, pounds per square inch	55.000-65,000	48,000-58,000
Yield point	½ ult. tens. str.	½ ult. tens. str.
Elongation, per cent. in 8 inches (minimum)	$\frac{1,400,000}{\text{ult. tens. str.}}$	$\frac{1,400,000}{\text{ult. tens. str.}}$
Character of fracture	Silky	Silky
Cold bend without fracture	180° to diameter of one thickness.	180° flat.

Finish.

94. All finished material shall be free from injurious seams, flaws and cracks, and have a workmanlike finish.

Variation In Weight.

95. When steel is inspected at the mill or shop all pieces (except plates), which vary in weight more than 2½ per cent. from that specified, shall be rejected, when steel is not inspected until it is delivered on the work such variation in weight will be sufficient cause for rejection when in the judgment of the Engineer the safety of the work will be impaired thereby.

Workmanship.

96. All structural steel shall be in accordance with the plan and approved shop drawings. All details not shown on the plan, and all workmanship and finish shall be equal to the best current practice in similar work for buildings.

Anchor Bolts.

97. Anchor bolts and expansion bolts shall be furnished where required and set in place as directed. When holes are drilled in masonry or concrete for such bolts, the holes shall be washed clean and the bolts shall be firmly embedded in a mortar composed of equal parts of cement and sand, unless other material is shown on the plan.

Melt Numbers.

98. Test specimens and every finished piece of steel shall be stamped with melt or blow number, except that small pieces may be shipped in bundles securely wired together, with the melt or blow number on a metal tag attached.

Tests And Inspections.

99. The required tests and inspections of structural steel shall, if directed, be made at the mills and shops by the city's authorized inspector. The Contractor shall notify the Engineer as to the mills and shops which are to supply the steel, sufficiently in advance to enable the Engineer to arrange for such tests and inspections and the mills and shops shall afford every facility for making the same.

Mill Certificates.

100. If it is decided not to make the tests and inspections at the mills, then mill certificates showing the properties of each melt of which the steel is made will be accepted for consideration.

Shipping Invoices.

101. The Contractor will be required to furnish complete copies of shipping invoices with each shipment of steel.

Certificates, Etc., For Information Only.

102. Steel will not be accepted until the required inspector's reports or mill certificates are received. All tests, inspection, reports and certificates are for the information of the Engineer, and he shall not be precluded on account thereof from requiring or making any further tests which he may deem necessary.

Shop Drawings.

103. The Contractor shall prepare complete and accurate shop drawings of all steel work, and no shop work shall be done until such drawings shall have been approved. The Contractor shall furnish to the Engineer 3 complete sets of prints of the approved shop drawings.

Painting.

104. All steel shall be thoroughly cleaned of scale, rust, oil and dirt, and unless otherwise directed, those parts which are not to be bedded in concrete shall be painted with a priming coat of the best red lead and linseed oil or such other paint of equivalent value as may be directed. After erection, the metal which will be exposed in the finished work shall be evenly painted with 2 coats of approved paint. No painting shall be done on wet surfaces.

Measurement.

105. The amount of structural steel paid for as such will be all structural steel placed in the work in accordance with the plan or directions, except any excess greater than 2½ per cent. above the weight required, and except such structural steel shown on the plan as part or parts of structures for which there are contract prices, and the cost of which is hereinafter specified to be covered by the contract prices for such structures.

Price To Cover.

106. The contract price for structural steel shall cover the cost of all labor and materials required to furnish, fabricate, erect and paint the same, to furnish all test pieces, to prepare and furnish prints of shop drawings, and to drill holes for and set anchor and expansion bolts, where required, all as specified.

STEEL REINFORCEMENT BARS.

Shape.

107. Steel bars for reinforcing concrete shall be of such shape as to afford an approved mechanical bond with the concrete and to insure intimate contact between the steel and concrete. Plain bars may be used only when shown on the plan.

Samples.

108. The Contractor shall indicate the type of bars proposed to be used and if required shall furnish samples thereof,

and he is cautioned not to place the order for bars until the type has been approved.

Size.

109. Each bar shall have a net cross sectional area equivalent to that designated on the plan or required, or it shall be the commercial size of the approved type of bar having a net cross sectional area next larger than that designated or required.

Variation In Weight.

110. Reinforcement bars will be rejected if the actual weight varies more than 5 per cent. from their theoretical weight, as shown by the manufacturer's tables. For weighing reinforcement bars the Contractor shall, whenever required, provide an accurate scale of an approved type, with a capacity of not less than 500 pounds.

Quality.

111. All steel for reinforcement bars shall be made by the open hearth process, and shall conform to the latest revised Standard Specifications for Steel Reinforcement Bars adopted by the American Society for Testing Materials.

The chemical and physical properties of the steel shall be as follows:

Properties Considered.	Structural Steel Grade. Plain bars.	Structural Steel Grade. Deformed bars.	Hard Grade.* Plain bars.	Hard Grade.* Deformed bars.	Hard Grade.* Cold twisted bars.
Phosphorus, maximum					
Bessemer	0.10	0.10	0.10	0.10	0.10
Open Hearth	0.05	0.05	0.05	0.05	0.05
Ultimate tensile strength pounds per sq. inch	55,000 to 70,000	55,000 to 70,000	80,000 min.	80,000 min.	Recorded only.
Yield point, minimum, pounds per sq. inch	33,000	33,000	50,000	50,000	55,000
Elongation, minimum, per cent. in 8" inches	1,400,000 / tens. str.	1,250,000 / tens. str.	1,200,000 / tens. str.	1,000,000 / tens. str.	5 per cent.

Cold bend without fracture:					
Bars under ¾-in. in diameter or thickness	180° d=1t.	180° d=1t.	180° d=3t.	180° d=4t.	180° d=2t.
Bars ¾-in. in diameter or thickness and over	180° d=1t.	180° d=2t.	90° d=3t.	90° d=4t.	180° d=3t.

*The hard grade will be used only when specified.
t=Nominal thickness or diameter of bar.

112. Reinforcement bars shall be rolled from billets of new steel; they shall be straight and free from seams, flaws, cracks and imperfections of all kinds.

Tests And Inspections.

113. The provisions of sections 95, 98, 99, 100 and 102 relating to tests and inspections of structural steel shall also apply to tests and inspections of steel reinforcement bars.

114. Test pieces 18 inches long may be cut from any of the bars delivered on the work, and the failure of any test piece to meet the specified requirements, or the failure of any bar when being tested or handled shall be deemed sufficient cause for the rejection of all steel from the melt from which the test piece or bar was made.

Protection.

115. Bars shall be protected at all times from mechanical injury and from the weather, and when placed in the work they shall be free from dirt, scale-rust, paint and oil. Bars which are to be embedded in concrete, but which remain exposed for some time after being placed in the work, shall, if directed, be immediately coated with a thin grout of equal parts of cement and sand.

Cutting And Bending.

116. Bars shall be bent to the shapes shown on the plan and in conformity with approved templets. When bars are

cut and bent on the work, the Contractor shall employ competent men and shall provide the necessary appliances for the purpose.

Placing.

117. All bars shall be as long as can be conveniently used, accurately bent, placed, spaced and jointed as shown or directed, and they shall be securely held in their positions by approved devices until the concrete has been placed around them.

Joints.

118. Where more than one bar is necessary to complete a required length the joints shall be made by means of approved clamps which will develop the full strength of the bars or by looping the ends of the bars around each other in such a manner as to produce and maintain tension on the joint during construction or by lapping the ends of the bars, as directed, and wiring them together in an approved manner, or by lapping the ends of the bars for a distance of 21 times their nominal diameters for deformed bars, and 40 times their nominal diameters for plain bars, and with a space not less than 2 inches between them. Joints in longitudinal bars shall be staggered as directed.

Measurement.

119. The weight of steel reinforcement bars paid for as such will be the weight computed from the lengths and theoretical net sections of the steel reinforcement bars placed in the work in accordance with the plan or directions, except such steel reinforcement bars shown on the plan as part or parts of structures for which there are contract prices, and the cost of which is hereinafter specified to be covered by the contract prices for such structures. The weight paid for will not include the lengths of bars used for laps or wires, clamps and other devices used for spacing, jointing and securing the bars in place, or lugs, corrugations and irregularities which increase the weight of the bars above the weight of plain

steel bars of the same net cross sectional areas, the cost of all of which shall be covered by the price bid for steel reinforcement bars. In computing the weight of bars, 1 cubic foot of steel will be considered to weigh 489.6 pounds.

PRICE TO COVER.

120. The concrete price for steel reinforcement bars shall cover the cost of all labor and materials required to furnish, clean, cut, bend, place, join, secure and protect the same, to furnish all test pieces and samples, all as specified.

WIRE NETTING.

TYPE, QUALITY, ETC.

121. Wire netting of approved type and quality, and of the mesh and gauge of wire shown on the plan shall be furnished and placed where shown or directed. The netting shall be of steel wire. When placed in the work, wire netting shall be free from dirt, paint, oil and rust-scale. It shall be securely held in place by an approved method until the concrete has been placed around it.

PRICE TO COVER.

122. The cost of all labor and materials required to furnish and place wire netting as specified shall be covered by the contract price for the structure or class of work in connection with which it is used.

EXPANDED METAL.

TYPE, QUALITY, ETC.

123. Expanded metal of approved type and quality and of the weight and size of mesh shown on the plan shall be furnished and placed where shown or directed. When placed in the work, it shall be free from dirt, scale, rust, paint and oil. It shall be placed in position with adjoining sheets lapped 1 mesh, and secured by an approved method until the concrete has been placed around it.

Measurement.

124. The amount of expanded metal paid for as such will be all expanded metal placed in the work in accordance with the plan or directions, except such expanded metal shown on the plan as part or parts of structures for which there are contract prices for such structures, and which is hereinafter specified to be covered by contract prices for such structures. The amount paid for will not include waste material cut from sheets, nor the material used for laps, nor wires, clamps and other devices used in joining and securing the expanded metal in place, the cost of all of which shall be covered by the contract price for expanded metal.

Price To Cover.

125. The contract price for expanded metal shall cover the cost of all labor and materials required to furnish, clean, cut, bend, place, join and secure the same as specified.

WROUGHT IRON.

Quality.

126. Wrought iron shall be double-rolled, tough, fibrous and uniform in quality. It shall be thoroughly welded in rolling and be free from surface defects. It shall have an ultimate tensile strength of at least 48,000 pounds per square inch, a yield point of 25,000 pounds per square inch, an elongation of at least 20 per cent. in 8 inches, and a fracture wholly fibrous. Specimens shall bend cold, with the fiber, through 180 degrees around a diameter equal to the thickness of the piece tested. When nicked and bent the fracture shall be at least 90 per cent. fibrous.

Galvanizing, Painting.

127. When required by the plan exposed wrought iron shall be thoroughly and uniformly galvanized. When not required to be galvanized exposed wrought iron shall be painted as specified in paragraph 104.

Measurement.

128. The amount of wrought iron paid for as such will be all wrought iron placed in the work in accordance with the plan or directions, except any excess greater than 2½ per cent. above the weight required, and except such wrought iron shown on the plan as part or parts of structures for which there are contract prices, and the cost of which is hereinafter specified to be covered by the contract prices for such structures.

Price To Cover.

129. The contract price for wrought iron shall cover the cost of all labor and materials required to furnish, fabricate, erect and galvanize or paint the same, as specified, and to furnish all test pieces required.

IRON CASTINGS.

Quality.

130. Iron castings shall be of the best foundry pig iron, gray, tough and free from cold shuts, blow holes and other imperfections. (The weight shall be conspicuously painted by the manufacturer with white oil paint on each casting.) The castings shall be sound, true to form and thickness, clean and neatly finished. Where required castings shall be thoroughly coated with coal tar pitch varnish.

Price To Cover.

131. The cost of all labor and materials required to furnish, place and coat the castings as specified, shall be covered by the contract price for the structure or class of work in connection with which they are used.

TIMBER.

Quality.

132. All timber shall be ... as specified, and shall be sound and free from shakes, cracks, large or loose knots, and

other defects impairing its strength or durability. It shall be squared to the required dimensions throughout its entire length.

Placing.

133. Timber shall be placed as shown on the plan or directed, and where necessary shall be firmly spiked or bolted with approved nails, spikes or bolts of such sizes and lengths and at such places and in such numbers as shown on the plan, or as directed.

Measurement.

134. The amount of timber to be paid for as such will be all timber placed in the work in accordance with the plan or directions, except piles and timber sheeting and except such timber shown on the plan as part or parts of structures for which there are contract prices, and the cost of which is hereinafter specified to be covered by the contract prices for such structures. The amount paid for will not include timber used for forms, templets, centers, scaffolds, bridges (unless otherwise specified), fences, guard rails or other temporary structures, the cost of all of which shall be covered by all the contract prices for all the items for which there are contract prices. No deduction will be made in the measurement of timber on account of the spaces occupied by the piles.

Price To Cover.

135. The contract price for timber shall cover the cost of all labor and materials required to furnish, work, place and secure the same as specified.

TIMBER SHEETING.

Quality, Placing, Etc.

136. Timber sheeting and the rangers and braces for the same shall be of a satisfactory quality of timber and of sufficient size and strength to adequately support the sides of the trenches and excavations. Sheeting shall be driven in

such a manner as to avoid cracking and splitting, and if required, for the proper prosecution of the work, shall be tongued and grooved.

When Paid For.

137. Timber sheeting will be paid for as such only when left in place by written order. When sheeting is left in, so much of it below the surface of the ground as may be directed shall be cut off.

Measurement.

138. The amount of timber sheeting to be paid for as such will be all timber sheeting, rangers and braces left in by written order, and will not include sheeting, rangers and braces left in place without such order, nor sheeting left in place because concrete is placed against it, nor that part of the sheeting that extended above the uppermost ranger after having been driven, the cost of all of which shall be covered by all the contract prices for all the items for which there are contract prices.

Price To Cover.

139. The contract price for timber sheeting shall cover the cost of all labor and materials required to furnish, place and cut off the sheeting, rangers and braces as specified, and shall also cover the cost of all excavation necessary to place the same.

PILES.

Quality.

140. Piles shall be of yellow pine or ..., as specified, sound and free from splits, shakes and other imperfections impairing their strength or durability. They shall be straight, taper uniformly from butt to point, and if so specified shall be barked. Unless otherwise shown on the plan, they shall conform to the following dimensions:

Length below cut-off.	Minimum diameter at point. inches.	Minimum diameter at cut-off. inches.
Less than 20 feet	6	10
20 feet to 25 feet	6	11
26 feet to 35 feet..............	6	12
36 feet to 45 feet..............	6	13
46 feet and over............	6	14

To determine the necessary length of piles to be used in the work, the Contractor may be required to drive test piles.

141. Each pile less than 60 feet long shall be in one piece; piles longer than 60 feet may be spliced in an approved manner. The small ends of piles shall be pointed, and, if required, shall be shod with approved *iron shoes*. The butt ends shall be cut off square and protected while driving with iron bands or caps.

How Driven.

142. Piles shall be driven without the use of a follower, unless specially permitted. Pile heads that become split or broomed shall be cut off and the driving continued. Any pile which splits, breaks or drives unsatisfactorily will not be paid for, and it shall be withdrawn or abandoned and another driven in place of it. After being driven, all piles shall be accurately cut off at the required elevation.

Bearing Piles.

143. Bearing piles shall be driven vertically and shall be spaced as shown on the plan or as directed. They shall be driven to a satisfactory refusal by a hammer having a concave face and weighing not less than 2,000 pounds. Refusal in general will be indicated by a penetration not exceeding 1 inch per blow under the last 6 blows of a 2,000-pound hammer falling 15 feet. If steam hammer pile drivers are used, the piles shall be driven so that their bearing power shall be not less than that of piles driven as herein specified. When it is shown on the plan or specified that piles are to be driven to a certain required depth, they shall be driven by the use of a water jet, hammer, or by any other approved method as may be necessary to reach this depth.

Brace Piles.

144. Where shown on the plan, brace, batter or spur piles shall be driven at the inclination shown or directed, and the tops shall be framed, bolted, or strapped to adjoining piles or to each other as shown on the plan.

Measurement.

145. The amount of piles to be paid for will be the total length below cut-off of all piles remaining in the work in accordance with the plan or directions, and the total length of all piles used only as test piles. Piles driven for temporary use will not be paid for.

Price To Cover.

146. The contract price for piles shall cover the cost of all labor and materials required to furnish, drive and cut off the same as specified, of fastening brace piles, and of furnishing and placing all shoes, bands, bars, straps, bolts and other fastenings required.

CONCRETE SEWERS.

Inverts.

147. Inverts of concrete sewers shall be formed between transverse templets and shall be screeded, unless other material is used for lining. The templets shall be placed at such intervals as to divide the invert into sections of suitable size for convenient construction, and unless otherwise permitted, the concrete shall be deposited in alternate sections and allowed to set before the remaining sections are built. Unless otherwise shown on the plan, a layer of mortar not less than ½ inch thick shall be spread evenly and to a smoothly finished surface upon the concrete of the invert as soon as such concrete is in place. Where the radii of inverts are too short to permit screeding between templets, the inverts shall be

shaped by means of suitable forms, which shall be removed as soon as the concrete has a sufficient set, and if required, the surfaces of inverts shall be floated or troweled to a smooth finish. The concrete for inverts shall be deposited continuously for their entire cross sections, and for such longitudinal distances as may be convenient. Where shown on the plan, inverts shall be lined with brick masonry, tile or other material, which shall be laid at such times and in such manner as may be directed. Inverts shall be carefully protected from all injury during progress of the work.

Side Walls.

148. Concrete in the side walls of sewers shall be deposited continuously to the height directed and for such longitudinal distances as may be convenient.

Roof.

149. Concrete in the roofs of sewers shall be deposited continuously for the full depths and widths of the roofs and for such longitudinal distances as may be convenient. The outer surfaces of roofs shall be finished with an excess of mortar and left true and smooth. They shall be covered and protected as specified in section 73, and such covering shall remain thereon until the backfilling or embankment is placed.

Bulkheads.

150. While being deposited concrete for sewers shall be confined by temporary vertical bulkheads placed at such intervals longitudinally as may be required for convenient working. The bulkheads shall be so designed as to give an approved shape to the end of the section of concrete under construction, shall be satisfactorily secured in place before the concrete is deposited, and shall remain in place until the concrete has set sufficiently to hold its shape.

RE-INFORCEMENT.

151. Where shown on the plan concrete sewers shall be re-inforced with metal of the dimensions and shapes shown, and of the quality and in the manner hereinbefore specified.

MINIMUM LENGTH OF INVERT.

152. Unless otherwise permitted or ordered, not less than 16 feet of foundation or invert for concrete sewer shall be built at one operation.

CONNECTIONS.

153. Connections and branches for lateral sewers and receiving basins shall be built in where shown on the plan or where directed. Such connections and branches shall be closed with bulkheads of brick masonry 8 inches thick unless otherwise shown on the plan. All necessary openings and bulkheads for branch sewers shall be built in concrete sewers where shown on the plan or where directed.

MEASUREMENT.

154. The lengths of concrete sewers will be determined by measurements along their inverts parallel to their center lines. No deductions will be made on account of openings at branches and manholes. The measurement of a branch concrete sewer will be made from the inner surface of the wall of the main sewer to which it connects. A reducer will be paid for at the contract price for the sewer at the larger end thereof.

PRICES TO COVER.

155. The contract prices for concrete sewers shall cover the cost of all necessary excavation (except rock, when there is a contract price for rock excavation); of furnishing, maintaining and removing all forms, centers templets, and temporary bulkheads; of all openings and bulkheads; also the removal of all bulkheads in the ends of sewers to which connection is made by the sewers in this contract; of all backfilling; of all embankments required; and of all labor and materials required to construct concrete sewers as shown by the normal sections on the plan and as specified.

BRICK SEWERS.

Inverts.

156. Inverts of brick sewers shall conform to lines drawn between transverse templets, and shall be lined with specially selected bricks, unless vitrified bricks are called for on the plan; no bats shall be used except for closers.

Arches.

157. The arches of brick sewers shall be built on substantial centers and shall be keyed with stretchers in full joints of mortar. No bats shall be used in the neat courses except for closers. The centers shall be true to the required shapes and sizes and shall be strong enough and so secured in place as to withstand all operations incidental to the construction of the arches. The extrados of the arches shall be smoothly and evenly plastered with a layer of mortar ½ inch thick. The centers shall be left in place until the mortar has set sufficiently to permit their removal without danger to the arches, and until the trench is backfilled for its full width to a height of at least 1 foot above the crown of the extrados of the arches. No centers shall be struck or removed until permission to do so has been given.

Minimum Length of Cradle.

158. Unless otherwise permitted or ordered, not less than 16 feet of foundation or cradle for brick sewer shall be built at one operation.

Branches, Measurements, Etc.

159. The construction of connections and branches for lateral sewers and receiving basins, and of openings and bulkheads and the measurement of brick sewers shall in all respects conform with the requirements hereinbefore specified for concrete sewers in sections 153 and 154.

Prices To Cover.

160. The contract prices for brick sewers shall cover the cost of all necessary excavation (except rock, when there is

a contract price for rock excavation); of furnishing, placing, maintaining and removing all templets and centers; of all openings and bulkheads, also the removal of all bulkheads in the ends of sewers to which connection is made by the sewers in this contract; of all backfilling; of all embankments required; and of all labor and materials required to construct brick sewers as shown by the normal sections on the plan and as specified.

VITRIFIED PIPE SEWERS.

Vitrified Pipe.

161. Vitrified pipe sewers and house connections shall be built of shale or clay hub and spigot pipes with deep and wide sockets. The pipes shall be manufactured at a suitable temperature, to secure a tough, vitreous material, without warps, cracks or other imperfections, and shall be fully and smoothly salt-glazed over the entire inner and outer surfaces, except that the inside of the hub and the outside of the spigot may be unglazed for two-thirds of the depth of the hub. On all other portions of the pipe the glazing shall completely cover and form an integral part of the pipe body. If not left unglazed the inside of the hub and the outside of the spigot shall be scored in 3 parallel lines extending completely around the circumference.

When it is broken, vitrified pipe shall show dense and solid material, without detrimental cracks or laminations; it shall be of such toughness that it can be worked with a chisel and hammer, and when struck with a hammer, it shall have a metallic ring.

Identification Marks.

162. Each pipe shall have clearly impressed on its outer surface the name of the manufacturer and of the factory in which it was made.

SHAPE AND DIMENSIONS.

163. The sizes of the pipes are designated by their interior diameters. Each pipe shall be a cylinder with a circular section, and shall have a uniform thickness.

164. The minimum lengths, thicknesses, depths of hubs and annular spaces for the respective sizes of vitrified pipes shall be as follows:

Size. inches.		Length. feet.	Thickness. inch.	Depth of socket. inches.	Annular space. inch.
6	not less than	2	⅝	2½	⅝
8	not less than	2	¾	2¾	⅝
10	not less than	2	⅞	2¾	⅝
12	not less than	2	1	3	⅝
15	not less than	2	1¼	[illegible]	⅝
18	not less than	2	1½	3¼	⅝
20	not less than	2	1 2-3	3½	⅝
22	not less than	2	1 5-6	3¾	⅝
24	not less than	2	2	4	⅝
27	not less than	2½	2¼	4	¾
30	not less than	2½	2½	[illegible]	¾
33	not less than	2½	2⅝	5	1¼
36	not less than	2½	2¾	5	1¼
42	not less than	2½	3½	5	1¼

CURVES, BENDS, ETC.

165. Where curved pipes are required they shall be furnished in either one-eighth or one-quarter bends of their respective sizes. Curved pipes, bends, siphons, and special pipe of the sizes and forms shown on the plan shall be furnished and laid, and unless otherwise provided they will be paid for at the contract prices for the corresponding sizes of vitrified pipe sewers.

SAMPLES FOR TESTING.

166. Any or all of the following tests may be applied to samples selected by the Engineer from the pipe delivered on the work. For the purpose of making such tests as may be required the Contractor shall furnish and deliver, when directed, and at the place required, one length of pipe for each 200 feet of pipe sewer to be laid.

Crushing Tests.

167. When supported at the bottom upon a knife edge one inch in width in such manner that an even bearing is provided throughout the whole length, exclusive of the bell, and pressure is applied at the crown uniformly through a similar knife edge, the various sizes of pipe shall withstand the following pressures:

Diameter. inches.	Pressure. lbs. per lin. ft.	Diameter. inches.	Pressure. lbs. per lin. ft.
6	900	22	1750
8	900	24	1950
10	1000	27	2150
12	1050	30	2350
15	1250	33	2500
18	1400	36	2800
20	1550	42	3200

Drop Weight Test.

168. When supported on a dry sand bed 2 inches deep, all pipe shall withstand without cracking the impact from 2 blows of a cast iron ball weighing 8 pounds falling 18 inches. Spurs shall resist without fracture the impact from 2 blows of such a ball falling 6 inches and striking on the extreme end of the hub of the spur.

Hydrostatic Test.

169. When subjected to an internal hydrostatic pressure of 10 pounds per square inch, vitrified pipe shall show no percolation.

Absorption Test.

170. After having been thoroughly dried and then immersed in water for 24 hours, sample pieces of vitrified pipe about 10 square inches superficial area with all broken edges shall not absorb more than 5½ per cent. of their weight of water.

(b) See insert at 701 and complete specifications as adopted by the 1915 Convention at page 828.

FACTORY REJECTION.

171. The entire product of any pipe factory may be rejected when, in the judgment of the Engineer, the methods of manufacture fail to guarantee uniform results, or where the materials used are such as produce inferior pipe, as indicated by repeated failure to comply with the tests herein specified.

CRADLES.

172. In earth trenches pipe sewers shall be laid in concrete cradles when required by the plan. In rock trenches pipe sewers shall be laid in cradles of concrete, gravel or broken stone or sand as shown on the plan.

WITHOUT CRADLE.

173. When the sewer is to be laid without a cradle the trench shall be excavated as specified in paragraph 15, and the earth forming the bed carefully freed of stones. The pipe shall then be evenly bedded therein, the joint properly made and the backfilling placed and firmly tamped in such a manner as to avoid disturbing the sewer.

CONCRETE CRADLE.

174. When the sewer is to be laid in a concrete cradle, the method of procedure, otherwise directed or permitted, shall be as follows, viz: The concrete for the full width of the cradle shall be deposited continuously to the height of the outside bottom of the pipe. Before the concrete has set the pipe shall be evenly bedded therein and the remainder of the concrete immediately deposited and carefully tamped in such a manner as to avoid disturbing the sewer.

GRAVEL OR BROKEN STONE CRADLE.

175. When the sewer is to be laid in a gravel or broken stone cradle, the latter shall consist of clean gravel or sound broken stone, all of which will pass through a 1-inch mesh,

and be retained on a $\frac{1}{8}$-inch mesh screen. The gravel or broken stone shall be deposited and tamped for the full width of the trench to the height of the outside bottom of the pipe. The pipe shall then be bedded therein and the remainder of the gravel or broken stone deposited and carefully tamped in such a manner as to avoid disturbing the sewer.

How Laid.

176. All pipes shall be laid with ends abutting and true to line and grade. The pipes shall be fitted together and matched so that when laid in the work they will form a sewer with a smooth and uniform invert. Unless otherwise permitted or directed, not less than ... feet of pipe sewer shall be laid in one operation.

177. Unless otherwise shown on the plan, the joints of vitrified pipe sewers shall be made as hereinafter specified in section 179.

Plain Mortar Joints.

178. Plain mortar joints shall be made in the following manner: Before a pipe is laid, the lower half of the hub of the preceding pipe shall be plastered on the inside with stiff mortar mixed 1 to 1, and of sufficient thickness to bring the inner bottoms of the abutting pipes flush and even. After the pipe is laid, the remainder of the hub shall be thoroughly filled with similar mortar and the joint wiped inside and finished to a smooth bevel outside.

Gasket and Mortar Joints.

179. Gasket and mortar joints shall be made in the following manner: A closely twisted hemp or oakum gasket of suitable diameter, in no case less than $\frac{3}{4}$ inch, and in one piece of sufficient length to pass around the pipe and lap at the top, shall be solidly rammed into the annular space between the pipes with a suitable calking tool. Before being placed, the gasket shall be saturated with neat cement grout. The remainder of the space shall then be completely filled

with plastic mortar mixed 1 to 1 and the joint wiped inside and finished to a smooth bevel outside.

Joints for sanitary sewers and bituminous compound for same.

180. Joints of sanitary pipe sewers below the normal water table shall be made with a compound approved by the Chief Engineer. The compound shall preferably have a bituminous base, shall adhere firmly to the glazed surfaces of the pipes, shall melt and run freely at a temperature as low as 250° F. and when set shall be sufficiently elastic to permit of a slight movement of the pipes without injury to the joints or breaking the adhesion of the compound to the pipes. The compound shall not deteriorate when submerged in fresh or salt water or normal domestic sewage. It shall show no deterioration of any kind when immersed for a period of five days in a one per cent. solution of hydrochloric acid or a five per cent. solution of caustic potash.

All sanitary pipe sewers below the normal water table shall be laid in concrete cradles as shown on the plans; the joints shall be carefully centered and calked as specified in article 179. After a joint is properly calked, a suitable runner shall be placed and the compound, heated to a temperature of approximately 400° F., shall be poured into it in such a manner that the annular space shall be completely filled to within one-half inch of the outer rim of the bell of the pipe.

After the joints are run and the concrete cradle is placed those portions of the joints not embedded in the cradle shall be encased in cement mortar, which shall extend at least two inches from the face and outside of the bell. The cement mortar shall be mixed in the proportions of one part of cement to one of sand.

Inspection of Joints.

181. Unless otherwise permitted, at least 4 finished joints shall be left exposed for inspection throughout the working day, and the necessary staging for the protection of the ex-

posed sewers and for the handling of excavated material shall be provided. A suitable ladder affording easy access for such inspection shall be furnished at every trench open for the proposed sewer. The joints on the inside of all pipe sewers larger than 15 inches in diameter, shall be carefully filled with mortar and wiped smooth and flush with the surface of the pipe.

Sub-Grade To Be Tested.

182. No pipe or the cradle therefor shall be laid or placed until the sub-grade of the trench shall have been tested and found correct.

Sewer To Be Kept Clean.

183. The interior of the sewer shall, as the work progresses, be cleared of all dirt, cement and superfluous materials of every description.

Backfilling.

184. Immediately after the sewer is laid the trench shall be backfilled as provided in sections 31, 32, 34, 35, 36, 37, 38 and 39. No walking on or working upon the completed sewer (except as may be necessary in tamping the backfilling) will be permitted until the trench has been backfilled to a height of at least 2 feet over the top of the sewer.

185. The exposed ends of pipe sewers shall be provided with approved temporary covers fitted to the pipe so as to exclude earth and other materials.

Branch Pipes.

186. Branch pipes and connection pipes shall be of the same quality and dimensions and laid in the same manner as specified for pipe sewers. Dead ends of pipes shall be closed with bulkheads of brick masonry 8 inches in thickness.

Connection With Existing Work.

187. Wherever the proposed sewer is to connect with an existing manhole in which there is a branch pipe which is

damaged or of unsuitable size or in improper position, such pipe shall be removed and be replaced with a pipe of suitable size or be reset in the proper position. The pipe so substituted or reset will be paid for at the contract price for the corresponding size of pipe sewer.

Pipes Cut To Fit Masonry.

188. The ends of pipes which enter masonry shall be neatly cut to fit the face of the masonry. When directed, such cutting shall be done before the pipes are built in.

Measurement.

189. The length of pipe sewers to be paid for will be determined by measurements along their invert lines, and no deductions will be made on accoount of openings at manholes.

Prices to Cover.

190. The contract prices for pipe sewers shall cover the cost of all necessary excavation (except rock when there is a contract price for rock excavation); of all sand, gravel, broken stone or concrete cradles required; of the making of all joints as specified; of all necessary trimming, fitting and building into masonry; of all bulkheads, also the removal of all bulkheads in the ends of sewers to which connection is made by the sewers in the contract; of all backfilling; of all embankments required; of all samples furnished; and of all labor and materials required to furnish and lay the sewers complete in place, as shown on the plan and as specified.

CEMENT CONCRETE PIPE SEWERS, WITHOUT RE-INFORCEMENT.

Shape And Dimensions.

191. Cement concrete pipes without re-inforcement, used in the construction of sewers, shall be hub and spigot pipes conforming in dimensions to the standard plan on file in the

office of the Engineer. Variations not greater than one-half (½) per cent. from such dimensions will be permitted.

192. Egg shaped sections for 12-inch and larger sizes shall have flat bases and shall be equal in quality to samples marked standard on exhibition at the Engineer's office.

Quality of Pipe.

193. When cement concrete pipe is broken it shall appear homogeneous, be entirely free from cracks or voids and generally uniform, showing pieces of fractured stone, firmly imbedded in the mortar.

Proportions.

194. The concrete used in the manufacture of cement concrete pipe shall be composed of a mixture of the best quality of Portland cement, clean, sharp sand and clean, broken stone or gravel suitably graded and equal in quality to similar materials specified herein for concrete, and properly proportioned to produce a pipe that will comply with all the requirements specified in sections 195 to 202, inclusive.

Method of Making.

195. Methods of molding, trimming and seasoning cement concrete pipe are left to the discretion of the manufacturer; as furnished, it shall be without warps, cracks or imperfections and shall present smooth inner and outer surfaces with no stones visible.

Delivery.

196. No pipe shall be delivered on the work or used within ... days after manufacture.

Inspection.

197. The materials used in the manufacture, the process of manufacture and the marking and dating of pipe shall be subject to inspection at the factory by inspectors designated by the Engineer.

Date of Molding.

198. All pipe shall have manufacturer's name and the date of molding clearly impressed on the outer surface as identification marks.

TESTS.

199. Sections 165, 166, 168, 169, 171, 172, 173, 174, relating to "curves, bends, etc.," "samples for testing," "drop weight tests," "hydrostatic pressure tests," "factory rejection," "cradles," "without cradles," "concrete cradles," and all sections 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189 and 190, relating to manner of laying, jointing, inspection, etc., etc., of vitrified pipe sewers shall govern in the manufacture of cement concrete pipe and the construction of cement concrete pipe sewers, wherever applicable. Crushing tests shall be applied as in section 167, except that flat base of pipe shall rest on sand bed not less than 2 inches thick, and pressure through a knife edge one inch thick shall be applied at the crown.

SPURS AND BRANCHES.

200. The manner of forming and joining spurs and branches with hubs of standard dimensions to cement concrete pipe shall be such as to insure a tight union, of ample strength to meet the requirements of the work and of the tests heretofore specified for spurs and branches on vitrified pipe.

ABSORPTION TESTS.

201. After having been thoroughly dried and then immersed in water for 24 hours, sample pieces of cement concrete pipe of about ten square inches superficial area, with broken edges, shall not absorb more than ten (10) per cent. of their weight of water.

DIMENSIONS.

202. The minimum lengths, thicknesses, depths of hubs and annular spaces for the respective sizes of cement concrete pipes shall be as follows:

Diameter. inches.	Length. feet.	Thickness. inches.	Depth of socket. inches.	Annular space.	
6	2	¾	2½	Not less than ⅝ inch.	
8	3	⅞	2½	Not less than ⅝ inch.	
10	3	1	2⅝	Not less than ⅝ inch.	
12	3	1¼	2¾	Not less than ⅝ inch.	And as
15	3	1½	2¾	Not less than ⅝ inch.	shown on
18	3	1¾	3	Not less than ¾ inch.	Standard
20	3	2	3	Not less than ¾ inch.	Plan.
22	3	2¼	3¼	Not less than ¾ inch.	
24	3	2½	3¼	Not less than 1 inch.	

CEMENT CONCRETE PIPE SEWERS WITH REINFORCEMENT.

Shape and Dimension.

203. Reinforced cement concrete pipes used in the construction of sewers shall be either circular in section without flat base, or egg shaped in section with flat base, and shall conform in dimensions to the standard plan on file in the office of the Engineer. Variations not greater than one-half (½) per cent. from such dimensions will be permitted.

Ends of Pipes.

204. The ends of such pipes shall be molded with hubs and spigots or with any other shapes which are satisfactory to the Engineer, and which will permit the making of tight, smooth and permanent joints. The shapes of the pipe ends shall be such as to require and permit the making and finishing of the joints both on the inside and outside of the sewer.

205. The pipes shall conform to the requirements in section 193 and shall be equal in quality to samples marked "Standard" on exhibition at the Engineer's office.

Dimensions, Etc.

[Note—Section 206 was not adopted. See page 678 for proposed substitute for Section 206.]

206. The minimum lengths, thicknesses and depths of hubs for the respective sizes of re-inforced concrete pipes shall be as follows:

Size. inches.	Lengths. feet.	Thickness. inches.	Depth of Socket. inches.
24	4	3	3½
30	4	3½	4
36	4	4	4½
42	4	4½	5
48	4	5	6
54	4	5½	6
60	4	6	6
66	4	6½	6
72	4	7	6
78	4	8	6
84	4	8	6

Type of Reinforcement.

207. The steel used for reinforcement of cement concrete pipe shall conform to the requirements for such material specified in section No. 111.

a. It shall be either expanded metal, rods or wire mesh, equal in quality and design to that manufactured by the American Steel and Wire Company.

b. Where reinforcement in pipes is exposed, it shall be thoroughly painted with cement grout so as to prevent deterioration by exposure to the weather, unless the reinforcement be galvanized.

Reinforcement For Circular Pipes.

208. In all sizes of circular reinforced cement concrete pipe from 24 inches to 48 inches diameter, inclusive, reinforcement shall be placed at distances varying from 1 inch to 1½ inches from the inner surfaces, according to diameter of pipes, as shown on the plan.

a. Either one or two lines of reinforcement may be used in the above sizes of pipes.

b. In all circular pipes whose diameters exceed 48 inches two lines of reinforcement shall be used, unless otherwise shown on the plan.

c. The inner line of reinforcement shall be placed two inches from the inner surface. The outer line of reinforcement shall be placed 1¾ inches from the outer surfaces.

Reinforcement For Egg Shape Pipe.

209. In all sizes of egg shaped reinforced cement concrete pipes, reinforcement shall be placed in such manner as to best resist stresses induced by external loads, and in a manner satisfactory to the Engineer. In all cases the shapes to which reinforcement shall be bent in the finished pipe shall be smooth and true, so that its position in the pipe shall conform at all points to that shown on the standard plan.

Samples For Testing.

210. Any or all of the following tests may be applied to samples selected by the Engineer from the pipe delivered on the work. For the purpose of making such tests as may be required, the Contractor shall furnish and deliver, when directed, and at the place required, three lengths of each size of pipes used in the work.

Crushing Tests.

[See page 678 for proposed substitute for Section 211.]

211. When tested in the manner described in Section No. 167, the various sizes of pipes between 24-inch and 42-inch in diameter, inclusive, shall withstand the following pressure:

When supported upon a saddle which extends the full length of the pipe exclusive of the bell and whose upper surface fits accurately the outer curved surface of the pipe, and whose width is equal to an arc of 15 degrees, in such a manner that an even bearing is provided throughout the whole length, and pressure is applied at the crown uniformly through a knife edge one inch in width, the various sizes of pipes with diameters greater than 42 inches shall withstand the following pressures:

Diameter. inches.	Pressure. lbs. per lin. ft.	Diameter. inches.	Pressure. lbs. per lin. ft.
24	1950	60	5000
30	2350	66	5500
36	2800	72	6000
42	3200	78	6500
48	3800	84	7000
54	4400		

212. Reinforced concrete pipe in which the reinforcement is not placed symmetrically about the circumference of the shell or in which only one concentric line of reinforcement is used, shall be tested in such a manner as to develop the same bending moments at the extremities of the vertical and horizontal diameters as will be developed at the crown by the tests specified above.

Hydrostatic And Absorption Tests.

213. When subjected to an internal hydrostatic pressure of ten (10) pounds per square inch, reinforced cement concrete pipe shall show no percolation.

Reinforced cement concrete pipe shall meet the requirements of the absorption test specified in Section 201.

214. Reinforced cement concrete pipes having openings to receive spur and branch connections shall be furnished and laid at such points as the Engineer may designate and as called for by the plan. The openings in pipes shall be made in accordance with a plan approved by the Chief Engineer, and the openings shall be such that connection may be made with the sewer in as effective a manner as is possible with pipes with molded spur connections.

General.

215. All the sections relating to vitrified pipe sewers and to cement concrete pipe sewers without reinforcement which are pertinent and applicable to reinforced cement concrete pipe sewers unless otherwise specified herein shall govern in all respects and details.

CAST IRON PIPE SEWERS.

Cast Iron Pipe.

216. Cast iron pipe for sewers shall conform with the requirements of the latest revised Standard Specifications for

Cast Iron Pipe adopted by the American Society for Testing Materials, and all tests required shall be made in accordance therewith.

217. The thickness of shell and weight of the several classes of pipe, and the allowable variations of diameter and weight shall be as follows:

Nominal Inside Diameter inches	Class A 100 foot Head 43 pounds Pressure Thickness inches	Class A Weight pounds	Class B 200 foot Head 80 pounds Pressure Thickness inches	Class B Weight pounds	Class C 300 foot Head 130 pounds Pressure Thickness inches	Class C Weight pounds	Allowable Variations Diam. inches	Allowable Variations Weight
4	0.42	240	0.45	260	0.48	280	0.06	5 p. c.
6	0.44	370	0.48	400	0.51	430	0.06	5 p. c.
8	0.46	515	0.51	570	0.56	625	0.06	5 p. c.
10	0.50	685	0.57	765	0.62	850	0.06	5 p. c.
12	0.54	870	0.62	985	0.68	1100	0.06	5 p. c.
14	0.57	1075	0.66	1230	0.74	1400	0.06	5 p. c.
16	0.60	1300	0.70	1600	0.80	1725	0.06	5 p. c.
18	0.64	1550	0.75	1800	0.87	2100	0.08	4 p. c.
20	0.67	1800	0.80	2100	[illegible]	2500	0.08	4 p. c.
24	0.76	2450	[illegible]	2800	1.04	3350	0.08	4 p. c.
30	0.88	3500	1.03	4000	1.20	4800	0.10	4 p. c.
36	0.99	4700	1.15	5450	1.36	6550	0.10	4 p. c.
42	1.10	6150	1.28	7100	1.54	[illegible]	0.10	4 p. c.
48	1.26	8000	1.42	9000	1.71	10900	0.12	4 p. c.
54	1.35	9600	1.55	11200	1.90	12700	0.15	4 p. c.
60	1.39	11000	1.67	13250	2.00	16100	0.15	4 p. c.

The above weights are for 12 feet laying lengths and standard sockets; proportionate allowance will be made for any variation therefrom.

Variation In Thickness.

218. For pipes whose standard thickness is less than 1 inch, the thickness of metal in the body of the pipe shall not be more than 0.08 inch less than the standard thickness; and for pipes whose standard thickness is 1 inch or more, the variation shall not exceed 0.10 inch, except that for areas not exceeding 8 inches in any direction, variations from the standard thickness of 0.02 inch in excess of the allowance above given will be permitted.

Coating.

219. All cast iron pipes shall be thoroughly and evenly coated inside and outside with coal tar pitch varnish. The

coating shall be smooth, tough and tenacious when cold and shall not be brittle or have any tendency to scale off.

Marking.

220. The weight and class letter shall be conspicuously painted by the manufacturer with white oil paint on the inside of each pipe after the coating is hard.

221. Joints of cast iron pipe sewers shall be of the kinds shown on the plan.

Lead Joints.

222. When lead joints are required, the inner portion of the annular space between the pipes shall be packed with clean, sound jute packing yarn and the remaining portions shall be run full of pure, soft lead and calked with suitable tools. Unless otherwise shown on the plan, the depths of the lead joints shall be 2½ inches for 6-inch to 8-inch pipe; 3 inches for 12- inch to 24-inch pipe, and 3½ inches for 30-inch to 48-inch pipe.

Mortar Joints.

223. When gasket and mortar joints or plain mortar joints are required they shall be made as specified in Sections 178 and 179.

224. All the requirements, as hereinbefore specified, relating to excavation, laying, backfilling and measurements of vitrified pipe sewers shall apply, as far as they are applicable, to cast iron pipe sewers.

Prices To Cover.

225. The contract prices for cast iron pipe sewers shall cover the cost of all necessary excavation (except rock when there is a contract price for rock excavation); of all sand, gravel, broken stone, or concrete cradles required; of the making of all joints; of all bulkheads; of all backfilling; of all embankments required and of all labor and materials required to furnish and lay the sewers complete in place, as shown on the plan and as specified.

BASIN CONNECTIONS.

226. The connections between receiving basins or inlet basins and sewers or manholes shall be of 12-inch vitrified pipe, unless otherwise shown on the plan. The pipes shall be of the same quality and dimensions and laid in the same manner as hereinbefore specified for vitrified pipe sewers.

MEASUREMENT.

227. The lengths of basin connections to be paid for will be determined by measurements along their inverts.

PRICE TO COVER.

228. The contract price for basin connections shall cover the cost of all necessary excavation (except rock, when there is a contract price for rock excavation); of all sand, gravel, broken stone, or concrete cradles required; of all necessary trimming, fitting and building into masonry; of all backfilling; of all embankments required; and of all labor and materials required to furnish and lay the basin connections complete in place, as specified.

PIPE DRAINS.

229. Pipe drains shall be built of vitrified or cement concrete pipe of the same quality and dimensions and laid in the same manner as hereinbefore specified for pipe sewers.

OLD DRAINS RESTORED OR EXTENDED.

230. Any existing drain encountered disturbed or removed on account of the work under this contract shall, if required, be restored or connected with the new work as directed. The portions of such drain restored or the extensions thereof will be paid for at the contract prices for pipe drains of the same size.

MEASUREMENT.

231. The lengths of pipe drains to be paid for will be determined by measurements along their inverts.

Prices To Cover.

232. The contract prices for pipe drains shall cover the cost of all necessary excavations (except rock, when there is a contract price for rock excavation); of all necessary trimming, fitting and building into masonry; of all backfilling; of all embankments required; and of all labor and materials required to furnish and lay the drains complete in place, as specified.

Spurs For House Connections.

233. Spurs for house connections shall be of vitrified or cement concrete pipe 6 inches in diameter, equal in quality and dimensions to that specified for pipe sewers.

In Brick And Concrete Sewers.

234. In brick and concrete sewers spurs shall be built in as shown on the plan or as directed. They shall be hub and spigot pipes with the spigot end moulded or cut to fit flush with the inner surface of the sewer, and of sufficient length to reach the exterior of the sewer.

In Pipe Sewers.

235. Pipes having 6-inch spurs with hubs moulded thereon shall be furnished and laid in pipe sewers where shown on the plan or directed. The cost of such pipes shall be included in the contract prices for pipe sewers.

Covers.

236. The ends of all spurs not connected with drains shall be closed with approved covers of the same material as the pipe. If required, such covers shalls be cemented in place, and when directed the covers shall be so cemented before the pipes are lowered into the trench.

Price To Cover.

237. The cost of spurs and all labor and materials required to furnish and place the same as specified, and furnishing

and cementing the covers for the same, shall be included in the contract price of the sewers to which they connect. They shall be furnished and laid as above specified without extra cost to the city.

DRAINS FOR HOUSE CONNECTIONS.

238. Where shown on the plan or where directed, drains or house connections shall be built from the spurs in such a manner and for such distance as may be shown or directed.

Depth at Curb.

239. Generally house connection drains shall be laid with such a gradient as to secure a depth at the curb line of 9½ feet or at a gradient of ¼ inch per foot. Where this is not possible or advisable, the depth at the curb line shall be as shown on the plan.

Material.

240. Unless otherwise shown on the plan, drains for house connections shall be of pipe of the quality and dimensions specified for pipe sewers. The ends of the drains shall be closed with approved covers of the same material as the pipe.

How Laid.

241. All the requirements, as hereinbefore specified, relating to excavation, laying and backfilling of pipe sewers shall apply, as far as they are applicable, to drains for house connections.

Measurement.

242. The lengths of pipe drains for house connections to be paid for will be determined by measurement along their inverts.

They shall be measured from the hub of the spur attached to the drain, sewer or riser.

Price To Cover.

243. The contract price for drains for house connections shall cover the cost of all necessary excavation (except rock,

when there is a contract price for rock excavation); the cost of all backfilling; the cost of all covers, bends and specials required; of all sand, gravel, broken stone or concrete cradles; and the cost of all labor and materials required to furnish and lay the drains for house connections complete in place, as specified and as shown on the plan.

Risers.

244. Where shown on the plan on where directed, risers for house connections shall be built from the spurs in such a manner and to such height as may be shown on the plan or directed. Unless otherwise shown on the plan, they shall be of pipe of the quality and dimensions hereinbefore specified for pipe sewers. They shall be supported and surrounded by concrete as shown, and each shall be closed with an approved cover of the same material as the pipe.

Measurement.

245. The lengths of risers to be paid for will be determined by measurements along their axes. They shall be measured from the hub of the spur attached to the main sewer.

Price To Cover.

246. The contract price for risers shall cover the cost of all necessary excavation (except rock, when there is a contract price for rock excavation); the cost of all concrete used in connection with the risers; the cost of all backfilling; the cost of all covers, bends, and specials required; and the cost of all labor and materials required to construct the risers complete in place, as specified.

MANHOLES.

247. The masonry or concrete for manholes shall be built to within ... inches of the established grade of the street or to within ... inches of the existing surface of the ground, as directed. When not built up to within ... inches of the

established grade of the street, the masonry or concrete shall, if directed, be covered with stone slabs not less than 5 inches thick or with an approved re-inforced concrete slab to support the head.

Brick Manholes.

248. Brick manholes shall be formed by means of templets placed at top and bottom with not less than 8 lines drawn between them if directed by the Engineer, and they shall be smoothly and evenly plastered on the outside with a layer of mortar ½ inch thick.

Concrete Manholes.

249. Concrete manholes shall be built of the materials, sizes and dimensions shown on the plan.

Steps.

250. Galvanized wrought iron steps of the size and shape shown on the plan shall be firmly built into the manholes at vertical intervals of about 16 inches.

Head And Cover.

251. Manhole heads and covers shall be of cast iron, and unless otherwise shown on the plan, each head, exclusive of cover, shall weigh not less than 475 pounds and each cover shall weigh not less than 135 pounds. The weight of each head and cover shall be conspicuously painted thereon by the manufacturer with white oil paint. The head shall be set on the masonry or concrete in a full bed of stiff mortar.

Dust Pans, Etc.

252. Where shown on the plan, dust pans and protective gratings of the materials, forms and dimensions shown shall be furnished and fitted in the manholes.

Price To Cover.

253. The contract price for manholes shall cover the cost of all necessary excavation (except rock, when there is a contract price for rock excavation); of all backfilling; of all

plastering; of all stone and concrete slabs; of all steps; of heads and covers; of dust pans and protective gratings, when required; and of all labor and materials required to construct the same complete, in place, as shown on the plan and specified.

RECEIVING BASINS.

Brick Basins.

254. Brick receiving basins shall be built in the manner and of the dimensions shown on the plan. They shall be equipped with heads and hoods or traps corresponding with the standard plan on file in the office of the Engineer. They shall be formed by means of templets placed at top and bottom with not less than 10 vertical lines drawn between them, if directed by the Engineer. If required, the outlets of receiving basins shall be closed with bulkheads of brick masonry and such bulkheads shall be removed when directed. The outside of the brickwork shall be smoothly and evenly plastered with a layer of mortar ½ inch thick.

Concrete Basins.

255. Concrete receiving basins shall be built in the manner and of the dimensions shown on the plan. Class A concrete shall be used throughout and shall be placed for both bottom and side walls at one operation.

Concrete Heads.

256. Where concrete heads or cover slabs of receiving basins or their inlets are built in or adjoin concrete sidewalks, the new work shall be made to correspond in pattern and color with the existing sidewalk.

Pavement at Inlets to Receiving Basins.

257. The pavements adjoining the inlets to receiving basins shall be restored and adjusted to the extent and in the manner directed, and in accordance with paragraphs ... and ... in unpaved streets and in macadamized streets, where

the inlets to the receiving basins are approximately at the surface of the street, a space of 2½ feet adjoining such inlets shall, if required, be paved with approved paving blocks.

Price To Cover.

258. The contract price for receiving basins shall cover the cost of all necessary excavation (except rock, when there is a contract price for rock excavation); of heads and inlets, traps and fittings; of the outlet culvert connecting with the sewer; of all backfilling; of all pavement required at the inlets to the basins; of the temporary brick bulkheads in the outlets of the basins or outlet culverts when required; and of all labor and materials required to construct the receiving basins complete in place, as shown on the plan and specified.

STORM WATER INLETS.

259. Storm water inlets and the heads and covers therefor shall be of the materials, forms and dimensions shown on the plan. If required, the mouth of inlets shall be closed with bulkheads of brick masonry and such bulkheads shall be removed when directed.

Price To Cover.

260. The contract price for inlets shall cover the cost of all necessary excavation (except rock, when there is a contract price for rock excavation); of all backfilling; of connections with sewers or basins; of the temporary brick bulkheads in the mouths of the inlets when required; and of all labor and materials required to construct the inlets complete, in place, as shown on the plan and specified.

Flush Tanks.

261. Flush tanks shall be of the materials, form and dimensions shown on the plan. Unless otherwise directed, they shall be connected with the water main and with the sewer.

The connection with the water main shall be made under a permit from the proper authorities, and under their rules and inspection.

PRICE TO COVER.

262. The contract price for flush tanks shall cover the cost of all necessary excavation (except rock, when there is a contract price for rock excavation); of all backfilling; and of all labor and materials required to construct the flush tanks complete, in place, as shown on the plan, and to connect the same with the water main and the sewer.

EMBANKMENT.

QUALITY.

263. Where indicated on the plan, embankment shall be made of the form and dimensions shown. It shall consist of clean steam ashes, or filling of the quality specified in Sections 31, 32 and 34, which shall contain no stone over 6 inches in its largest dimension. When the material forming the embankment contains stones, the latter shall be so distributed through the mass that all interstices are filled with fine material, and the material within 2 feet of the sewer shall be free of stones. When embankment is used as foundation it shall consist entirely of filling of the quality specified in Sections 31 and 32.

HOW MADE.

264. The embankment shall be deposited and spread in horizontal layers to such an extent and at such times as may be directed. When embankment is used as a foundation, the ground on which it is to be made shall be prepared by grubbing and clearing, and removing all improper material. Embankment used as foundation shall be deposited in uniform horizontal layers not exceeding 1 foot in depth, and each layer shall be thoroughly compacted by rolling or tamping, or both; such embankment shall not be built upon until the expiration of. . . . days after its completion.

Approaches.

265. Where the embankment obstructs or interferes in any way with any public or private roadway, the Contractor shall furnish and place all material necessary to provide suitable approaches of such widths and to such extent as shown on the plan, or as directed.

266. All embankments and approaches shall be maintained at their full dimensions until the completion of this contract.

Price To Cover.

267. The cost of all labor and materials required to prepare the ground, to make the embankment and approaches as specified, to make all necessary excavations and backfilling therein, and to maintain the embankments and approaches at their designated dimensions until the completion of this contract, shall be covered by the contract prices for the structures over or in connection with which they are made.

SLOPE PAVEMENT.

How Laid.

268. Slope pavement shall be not less than 18 inches in depth and shall be composed of sound quarried or split stones. Except when used for pinning or wedging, the stones shall be not less than 6 inches thick and from 12 to 18 inches long. They shall be placed by hand so as to present a fairly even surface, and have their longest dimensions approximately perpendicular to the side of the embankment. At least one-third of the stones shall extend through the pavement. Slope pavement will be measured by its superficial area.

Price To Cover.

269. The contract price for slope pavement shall cover the cost of all labor and materials required to lay the same complete, in place, as specified.

RESTORATION OF SURFACE AND CLEANING UP.

Restoration of Unpaved Roadways, Sidewalks, Etc.

270. At such time as may be directed, all unpaved roadways, gutters, and sidewalks affected by the work done under this contract shall be restored by the Contractor to the same condition in which they were at the time of the opening of bids for this contract.

Pavements, Etc., Restored By City.

271. Unless otherwise required by the plan, all roadway and sidewalk pavements, cross-walks, curbs, etc., along the line of the work (except those under guarantee for maintenance by the paving Contractor), which are removed, destroyed, lost or injured on account of, or during the construction of the work under this contract, or which are injured by traffic on account of any act or omission on the part of the Contractor, his agents, servants or employes, in the prosecution of the work, will be restored and adjusted by the city at the expense of the Contractor. For this purpose, before the completion of the contract, and when directed, the Contractor shall pay to the city a sum of money sufficient to cover the cost of restoring and adjusting the pavements, cross-walks, curbs, etc., the amount of the work to be done being determined by the Engineer, and the cost being computed at the following prices:

Granite block with concrete foundation, tar and gravel (or cement grout) joints..................................	$ per sq. yd.
Granite block pavement, with sand foundation..............	
Medina block pavement, with concrete foundation (grouted joints)	
Brick pavement with concrete foundation..................	
Brick pavement, with sand foundation......................	
Belgian block pavement....................................	
Cobble stone pavement.....................................	
Macadam pavement	
Iron slag pavement..	
Wood block pavement.......................................	
Asphalt block pavement over 10 yds........................	
Asphalt block pavement under 10 yds.......................	

Sheet asphalt pavement, with concrete foundation, over 10 yds.	
Sheet asphalt pavement, with concrete foundation, under 10 yds..	
Asphalt pavement, without concrete foundation, over 10 yds..	
Asphalt pavement, without concrete foundation, under 10 yds.	
Cement sidewalk relaid..................................	$ per sq. ft.
New flagging	
Flagging relaid	
Curbstone reset, sand foundation.........................	$ per lin. ft.
Curbstone reset, concrete foundation......................	
New curbstone furnished and set, sand foundation..........	
New curbstone furnished and set, concrete foundation.......	
Bridgestone reset, sand foundation........................	$ per sq. ft.
Bridgestone reset, concrete foundation.....................	
New bridgestone furnished and set, sand foundation.........	
New bridgestone furnished and set, concrete foundation.....	

Pavements, Etc., Restored By Contractor.

272. If required by the plan, roadway and sidewalk, pavements, cross-walks, curbs, etc., except those under guarantee for maintenance, shall be satisfactorily restored and adjusted by the Contractor at such times as may be directed. Sidewalk pavements shall be restored in whole flags, squares or sections which shall correspond in quality and appearance with the original or adjoining flags, squares or sections. All work and materials used in such restoration and adjustment shall conform in all respects to the standard specifications now in use by the city for similar work and materials.

Pavements, Etc., Under Guarantee.

273. All pavements, sidewalks, cross-walks, curbs, etc., existing at the time of the opening of the bids for this contract, and under guarantee for maintenance, shall be restored and adjusted by the parties responsible under such guarantee, and at the expense of the Contractor. If not so restored and adjusted during the progress of the work, the Contractor shall, when directed, pay to the city, before the completion of the contract, a sum of money sufficient to cover the cost of having the same restored and adjusted by the parties responsible under such guarantee, and at the charges for the restoration

of the same, as set forth in their contracts relating thereto. Such sum shall be accompanied by certificates from the parties responsible for the maintenance of the pavements, sidewalks, cross-walks, curbs, etc., to the effect that such sum will be accepted by them as covering the entire quantity of pavement, etc., to be restored and adjusted.

Temporary Restoration.

274. At such times as may be directed roadway and sidewalk pavements, cross-walks, curbs, etc., which have been removed, whether under guarantee or not, shall be temporarily restored by the Contractor to the satisfaction of the Engineer.

Change of Pavement, Etc.

275. When the kinds of pavements, sidewalks, cross-walks, curbs, etc., in any street affected by this contract, are changed after the bids are opened and before work is commenced, the Contractor will not be required to make permanent restoration of the new pavement, sidewalks, cross-walks, curbs etc., disturbed, but a sum of money sufficient to pay the cost of replacing the kinds of pavement, sidewalks, cross-walks, curbs, etc., which were there at the time of the opening of the bids for this contract, will be deducted from the amount which would have been payable to the Contractor upon the completion of the contract, had the character of pavements, etc., not been changed, and such cost will be computed at the prices stated in section 269.

When New Pavement Is Laid.

276. If pavement, sidewalks, cross-walks, curbs, etc., are laid where none existed at the time the bids for this contract were opened, the Contractor shall excavate and remove such portions of the pavements, sidewalks, cross-walks, curbs, etc., and their foundations as may be necessary for the prosecution of the work, but he will not be required to make a permanent restoration of them.

Trenches Flooded.

277. Before laying any pavements, sidewalks, cross-walks, curbs, etc., the trenches shall, if required, be flooded with water, as directed, and all resulting holes or depressions shall be filled and tamped solid.

Unnecessary Cross Gutters.

278. All cross gutters rendered unnecessary by the work under this contract shall be removed and the entire street intersection or so much thereof as may be necessary shall be regraded and re-paved as herein specified.

Cleaning-Up.

279. At such times as may be directed, the Contractor shall remove from the streets all materials which were placed thereon by him as a consequence of performing this work, and which are not required by the contract to be left as part of the finished work. The entire work and portions of the street affected thereby shall be left in a satisfactory condition. The sidewalks and cross-walks shall be swept clean of all material which may have accumulated thereon by reason of the work performed under this contract, and if required, they shall be sprinkled with water during the sweeping.

Prices To Cover.

280. The cost of all the labor required to be done and all the materials required to be furnished in the performance of all the work specified in Sections ..., inclusive, shall be covered by all the contract prices for all the items for which there are contract prices.

[Proposed substitute for Art. 206.]

PARAGRAPH ON DIMENSIONS AND REINFORCEMENT.

Reinforced concrete pipes shall have the following general dimensions and details.

Size.	Min. Length.	Min. Thickness.
24	4 feet	2½ inches
30	4 feet	2¾ inches
36	4 feet	3 inches
42	4 feet	3½ inches
48	4 feet	4 inches
54	4 feet	4½ inches
60	4 feet	5 inches
66	4 feet	5¼ inches
72	4 feet	5½ inches
78	4 feet	5¾ inches
84	4 feet	6 inches

The depth and details of socket and spigot ends shall be such as to insure a water tight joint and shall meet the approval of the Engineer.

Reinforcement shall consist of wires, rods, expanded metal or other standard reinforcement material and shall be so disposed as to efficiently reinforce the pipe when laid, at all points, in a manner satisfactory to the Engineer. In general there shall be a clearance between the reinforcement and the surface of the pipe at least equal to the diameter of the bar and never less than ¾-inch.

[Proposed substitute for Art. 211.]

CRUSHING TESTS.

The standard crushing requirements shall be the ability of the pipe to withstand a load equivalent to the vertical weight of backfilling in a trench 20 feet deep, on the assumption that the pipe will not have lateral support. For damp yellow clay these loads are assumed to be as follows when supported as an evenly distributed load over full width of the pipe and the pipe is supported equally throughout the 180 degrees of invert without lateral support:

24— 3,850 lbs. per lin. ft. pipe
30— 4,400 lbs. per lin. ft. pipe
36— 4,800 lbs. per lin. ft. pipe
42— 5,600 lbs. per lin. ft. pipe
48— 6,600 lbs. per lin. ft. pipe
54— 7,500 lbs. per lin. ft. pipe
60— 8,000 lbs. per lin. ft. pipe
66— 8,800 lbs. per lin. ft. pipe
72— 9,400 lbs. per lin. ft. pipe
78—10,000 lbs. per lin. ft. pipe
84—10,400 lbs. per lin. ft. pipe

Should it be considered too difficult to make the loadings on the full diameter as described, the tests may be made by distributing a load evenly over a sand box area of 45 degrees on each side of the upper center line, and supporting the pipe and load upon an equal sand area at the bottom. In this case in order to produce bending moments at the crown which would be produced by the above standard loads, the loads shall be according to the following schedule:

24—2,600 lbs. per lin. ft. pipe
30—3,400 lbs. per lin. ft. pipe
36—3,700 lbs. per lin. ft. pipe
42—4,300 lbs. per lin. ft. pipe
48—5,100 lbs. per lin. ft. pipe
54—5,800 lbs. per lin. ft. pipe
60—6,200 lbs. per lin. ft. pipe
66—6,800 lbs. per lin. ft. pipe
72—7,300 lbs. per lin ft. pipe
78—7,700 lbs. per lin. ft. pipe
84—8,000 lbs. per lin. ft. pipe

In this case, however, since the load produces a less bending moment at the horizontal points or springing lines than when the standard load is applied over the full width of the pipe, or as it is in actual trench condition, the springing line of the pipe when analyzed as a reinforced concrete section shall have enough reinforcement along and near the outer surface of the ring to give a calculated moment of resistance equal at least to nine-tenths of the calculated moment of resistance at the top and bottom points.

Should the Engineer prefer to use concentrated load tests by applying the load along knife edge bearing and supporting the pipe upon similar bearing at the base, as described in section 162, then the loads which the pipe shall sustain shall be as follows:

24—1,350 lbs. per lin. ft. pipe
30—1,750 lbs. per lin. ft. pipe
36—1,900 lbs. per lin. ft. pipe
42—2,200 lbs. per lin. ft. pipe
48—2,600 lbs. per lin. ft. pipe
54—3,000 lbs. per lin. ft. pipe
60—3,200 lbs. per lin. ft. pipe
66—3,500 lbs. per lin. ft. pipe
72—3,700 lbs. per lin. ft. pipe
78—4,000 lbs. per lin. ft. pipe
84—4,100 lbs. per lin. ft. pipe

In this case the strength of the pipe, or its resistance against widening at the horizontal diameter shall be tested by calculation and in comparison with the calculated strength of the ring at the top and bottom shall conform to the requirements described in the preceding paragraph for tests with 90 degree distribution of vertical load.

REPORT OF SUB-COMMITTEE ON SPECIFICATIONS FOR WOOD BLOCK PAVING.

Your Sub-Committee on Wood Block Paving appointed for the purpose of preparing specifications for wood block pavements begs leave to report that they have carefully considered the specifications of the Society and the Association for Standardizing Paving Specifications, which is now a part of this Society. The two specifications above referred to were very nearly alike, only a variation in minor requirements. We have endeavored to amalgamate in a way these two specifications and also to supplement by whatever of advancement or improvement may have been acquired by experiment or experience in the manufacture or use of wood blocks.

In the matter of woods to be used, the specifications herewith submitted only mention four, which are the principal supplies to be drawn from in most of the United States and Canada. There may be local conditions which could be supplied with some other equally good wood and a specification might be made by the engineer permitting the use of such wood. There are woods, however, which experience has shown are not desirable to use in the present state of the industry although time might show a method whereby such woods might be used. In regard to the fineness of the wood, we think that a specification which is the most simple and the easiest to apply should be made and have, therefore, made a change simplifying the requirements and following the Forest Service specifications for structural timber in a way.

There has been quite a discussion as to the kind of oil or preservative to use and attributing some of the defects (if you might call them that, more particularly "bleeding and bulging") of wood block paving to the use of a tar oil. Your committee cannot see the logic of the argument nor the lessening of such defects by the use of the distillate oil. We, how-

ever, see no reason why such an oil should not be used successfully but can see no reason for increasing the price of the preservative fifty (50) per cent. without any apparent advantage. We, therefore, submit a specification for such oil. We have endeavored to draw a specification which would require for the mixture of tar and oil a good preservative and waterproofing oil. We are of the opinion that the so-called bleeding and bulging of creosoted wood block paving is caused primarily by the method of treatment and that the treating plants have been trying to get out the largest quantity of blocks possible without paying attention to the proper method of treatment. This is well shown in the paper presented to this Society by Mr. Teasdale of the Forest Product Laboratory, Madison, Wis., and from these tests it is very evident that the method of treatment influences bleeding almost entirely and not the quality of the oil. We have endeavored, therefore, to provide a way for the engineer to have a proper treatment made and which would add practically nothing to the cost of the blocks.

In regard to the remaining paragraphs of the specifications we have made only a few minor changes from the standard specifications.

In regard to the thickness of the concrete, the tendency is to increase the thickness rather than diminish. This is along the right lines as the improvement of the roads allows the transportation of larger loads. There should be a limit as to those loads to at least protect the large amount of paving already constructed.

As to the cushion and filler several methods have been included as different conditions as to traffic and local conditions might warrant different construction.

These specifications are gotten up for use of the engineers and supervisors on wood block paving. We think, however, that it would be an excellent idea to have the committee consult with and to have the co-operation of the lumber manufacturers and also the wood preservers, and we would recom-

mend that the committee be authorized to take the matter up with similar committee of the lumber manufacturers and of the wood preservers' association.

ELLIS R. DUTTON.
A. W. DOW.
Committee.

SPECIFICATIONS FOR CREOSOTED WOOD BLOCK PAVING.

[These specifications have not been adopted, but are printed for information and discussion at the convention at Dayton, Ohio, Oct. 11-15, 1915.]

NOTE—These specifications will be modified from time to time to keep them fully up to date. Suggestions as to modifications or additions are solicited and should be sent to the Secretary, or to Ellis R. Dutton, City Hall, Minneapolis, Minn., Chairman of the Sub-Committee on Specifications for Wood Block Paving, and George W. Tillson, Boro Hall, Brooklyn, N. Y., Chairman of General Committee on Standard Specifications.

RECOMMENDED BY THE SUB COMMITTEE ON STANDARD SPECIFICATIONS FOR WOOD BLOCK PAVING.

TIMBER.

1. The wood to be treated shall be Southern Yellow Pine, Norway Pine, Douglas Fir or Tamarac; but only one kind of wood to be used in any one contract.

The blocks must be cut from good grade of timber which must be well manufactured, full size, square butted and square edges, free from the following defects: Checks, unsound, loose or hollow knots, knot holes, worm holes, through shakes and round shakes that show on the surface. The annular rings in the 1-inch, which begins one inch from the center of the heart of the block, shall not be less than six. In case the block does not contain the heart, the 1-inch to be used shall

begin with the annular ring which is nearest the center of the heart. No block shall contain less than fifty (50) per cent. of heart wood.

Size of Blocks.

2. The blocks shall be from five (5) to ten (10) inches long, but shall average eight (8) inches. The depth of the blocks should be four (4) inches on all streets where there is any considerable amount of heavy traffic. On lighter traffic streets it may be reduced to three and one-half inches (3½"); or to three (3) inches on light traffic or residential streets. In case the blocks are three (3) inches in depth they shall not exceed eight (8) inches in length. They may be from three to four inches in width, but in any one city block all of them shall be of uniform width. A variation of one-sixteenth (1-16) inch shall be allowed in the depth, and one-eighth (⅛) inch in the width of the blocks from that specified.

Preservative.

3. The preservative to be used shall be a product of coal gas or coke oven tar, which shall be free from all adulterations and contain no raw or unfiltered tars, petroleum compounds, or tar products obtained from processes other than those stated.

The specific gravity shall not be less than one and eight hundredths (1.08) nor more than one and fourteen hundredths (1.14) at a temperature of thirty-eight (38) degrees centigrade.

Not more than three and one-half (3½) per cent. shall be insoluble by continuous hot extraction with benzol and chloroform.

On distillation, which shall be made exactly as described in Bulletin No. 65 of the American Railway Engineering and Maintenance of Way Association, as shown in the appendix to these specifications, the distillate based on water free oil shall be within the following limits and an average of a num-

ber of tests shall show a mean of these percentages, viz: Up to

150 degrees Centigrade	—Nothing must come off.	
170 degrees Centigrade	0 to 0.5	per cent.
210 degrees Centigrade	2 to 6	per cent.
235 degrees Centigrade	8 to 16	per cent.
315 degrees Centigrade	30 to 45	per cent.
355 degrees Centigrade	45 to 60	per cent.

The gravity of distillate distilling between 235 degrees and 315 degrees centigrade shall be not less than one and two hundredths (1.02) at sixty (60) degrees centigrade compared with water at sixty (60) degrees centigrade.

The preservative shall contain not more than three (3) per cent. of water.

The manufacturer of the blocks shall permit full and complete sampling at all times and places, and shall, if required, furnish satisfactory proof of the origin of the preservative.

Note—If a city desires a pure coal tar distillate the material insoluble in benzol and chloroform shall be less than one (1) per cent.

Treatment.

4. The blocks shall be treated in an air-tight cylinder with the preservative as heretofore specified. They shall first be subjected to steam at a temperature between 220 degrees F. to 240 degrees F. after which a vacuum of not less than twenty (20) inches shall be drawn and the temperature at the same time maintained at 150 degrees F. to 240 degrees F. While the vacuum is still on, the preservative oil, heated to a temperature of 170 degrees to 200 degrees F. shall be admitted and pressure gradually applied until a sufficient amount of the preservative oil has been forced into the blocks. After this, if it is desired, a supplemental vacuum, steam or both shall be applied. At the completion of thte treatment the blocks shall contain not less than *eighteen (18) pounds of water free oil per cubic foot of wood contained in that particular charge. Not more than ten (10) per cent. of excess

*Note—This amount may range from sixteen (16) to twenty (20) pounds, at the discretion of the Engineer, dependent on local conditions.

above the amount specified shall be allowed. They shall, after treatment, show satisfactory penetration through and through of the preservative, and all blocks that have been warped, checked or otherwise injured in the process of treatment shall be rejected.

The surface of the blocks shall be clean and free from any deposit of tar or other foreign substance.

Inspection.

5. The blocks shall be inspected at the plant and the manufacturer of the blocks shall equip his plant with all the necessary gauges, appliances and facilities to enable the inspector to satisfy himself that the requirements of the specifications are fulfilled. He shall allow an authorized representative of the city to inspect all materials and all parts of the plant during the manufacture of the paving blocks.

After delivery upon the street the blocks shall be subjected to a further inspection and all imperfect blocks shall be rejected and removed from the street by the Contractor.

Foundation.

6. The base shall be of concrete made in accordance with the specification of concrete paving foundations and shall be preferably six (6) inches in thickness. At the discretion of the Engineers on lighter traffic streets the thickness may be reduced to five (5) inches.

CUSHION.

A—Sand.

7. The blocks shall be laid on a sand cushion one (1) inch in thickness spread on the concrete foundation. The sand cushion shall be struck by templates to a surface parallel to the grade and contour of the finished pavement in such a manner that when the blocks are set and properly bedded in the sand, the tops shall conform accurately to the finished grade of the pavement. The sand used in this cushion shall all pass a quarter inch screen and be clean and sharp.

B—MORTAR.

8. Upon the concrete foundation shall be spread a layer of mortar one (1) inch in thickness and made of one part of Portland cement of the character provided for use in the foundation and three parts of sand. Only sufficient water shall be added to this mixture to insure a proper setting of the cement, the intention being to produce a granular mixture which may be raked to the desired grade. The mortar shall be thoroughly mixed and shall be spread in place on the foundation, immediately in advance of the block laying, to such a thickness that when the blocks are set and properly bedded in the mortar, their tops shall conform accurately to the finished grade of the roadway. The concrete foundation shall be cleaned and swept and shall be thoroughly dampened immediately in advance of placing the mortar bed. The mortar bed shall be struck by templates to a surface parallel to the grade and contour of the finished pavement.

C—BITUMINOUS.

9. Under special conditions, especially where vibration may be expected, mortar cushion may be omitted and a bituminous coating, spread upon a smoothly finished and thoroughly dry concrete base, substituted therefor.

FILLER.

10. When the blocks are laid upon the sand cushion the joints between the blocks shall be filled with a suitable bituminous filler.

When the blocks are laid upon a mortar or bituminous cushion the joints may be filled with sand or bituminous filler

EXPANSION JOINTS.

11. A longitudinal expansion joint not less than three-quarters (¾) of an inch in width and filled with a suitable bituminous filler shall be placed along the curbs.

LAYING BLOCKS.

12. Upon the bed thus prepared the blocks shall be carefully set with the fiber of the wood vertical in straight parallel courses, except that one row of blocks shall be placed parallel with the curb and three-quarters of an inch therefrom.

The blocks shall be laid by setting them loosely together on the cushion coat, but no joint shall be more than one-eighth (1/8) inch in width. Nothing but whole blocks shall be used, except in starting a course or in such other cases as the city may direct, and in no case shall the lap joint be less than two (2) inches. Closures shall be carefully cut and trimmed by experienced men. The portions of the blocks used for closure must be free from check or other fracture, and the cut end must have a surface perpendicular to the top of the block and cut to the proper angle to give a close tight joint.

After the blocks are placed, they shall be rolled parallel and diagonal to the curb by a steam roller weighing at least five (5) tons until the surface becomes smooth and is brought truly to the grade and contour of the finished pavement. When laid on a mortar bed, the rolling shall be completed before the mortar has set and all mortar that has set before the blocks are in place and rolled shall be discarded and replaced by fresh mortar.

After the blocks have been thoroughly rolled, the joints between them shall be filled with the filler selected.

After inspection by the proper city official, the surface of the wood block pavement shall be covered to a depth of about one-half (1/2) inch with fine screened sand. This sand is to be left upon the pavement for such time as may be directed by the proper city official, after which it shall be swept up and taken away by the Contractor.

Note—Engineers should not use this specification as a whole, but should make a selection of material and method where more than one is indicated under the different headings.

SPECIFICATIONS FOR ANALYSIS OF COAL TAR CREOSOTE.

SAMPLE.

13. In view of the fact that everything depends upon the samples taken for analysis, too much care cannot be used to make sure that such samples are strictly average ones to the whole bulk of the oil

To this end the oil should be completely liquified and well mixed before any samples are taken. Wherever possible, a drip sample of not less than two gallons should be taken, commencing after the oil has started to run freely. Where this cannot be done, as for instance in large storage tanks, samples should be taken from various depths in the tank, by means of a tube or bottle, the number of samples depending on local conditions.

For taking samples during the process of treatment, it is desirable to take a sample of oil from the storage tank about one foot from the bottom of the tank before the cylinder is filled, and, where possible, a sample directly from the cylinder during the process of treatment. For this purpose a thermometer well, as shown in attached figure, is recommended.

The sample to be analyzed should be thoroughly liquified by heating until no crystals adhere to a glass stirring rod, and also well shaken, after which one-half shall be taken for analysis and the balance reserved as a check test.

APPARATUS.

14. The apparatus for distilling the tar oil or creosote must consist of a stoppered glass retort similar to that shown in diagram, having a capacity as nearly as can be obtained of eight ounces up to the bend of the neck when the bottom or retort and the mouth of the offtake are in the same plane. A nitrogen-filled mercury thermometer of good standard make, divided into full degrees centigrade, must be used in connection therewith. The bulb of the retort and at least two inches of the neck must be and remain covered with a shield of heavy asbestos paper, shaped as shown in diagram, during

the entire process of distillation, so as to prevent heat radiation, and between the bottom of the retort and the flame of the lamp or burner two sheets of wire gauze, each 20-mesh fine, and at least six inches square, must be placed.

It is also recommended that the flame be protected against air currents. An ordinary tin can, from which a portion of the bottom and all of the top have been removed, placed on a support attached to the burner, as shown on diagram, has been found to answer the purpose.

DISTILLATION.

15. Before beginning the distillation, the retort should be carefully weighed and exactly one hundred grammes of the oil placed therein, the same being placed in the retort. The thermometer should be inserted in the retort with the lower end of the bulb one-half inch from the surface of the oil, and the condensing tube attached to the retort by a tight cork joint. The distance between the bulb of the thermometer and the end of the condensing tube should not be less than twenty nor more than twenty-four inches, and during the progress of the distillation, the thermometer must remain in the position originally placed.

The distillates should be collected in weighed bottles and all fractions determined by weight. Reports are to be made on the following fractions:

0 to 170 degrees centigrade.
170 to 200 degrees centigrade.
200 to 210 degrees centigrade.
210 to 235 degrees centigrade.
235 to 270 degrees centigrade.
270 to 315 degrees centigrade.
315 degrees centigrade and above.

For practical purposes there will be no need of reporting on all of these fractions It will be sufficient to report on the fractions as follows:

Below 200 degrees centigrade.
200 to 210 degrees centigrade.
210 to 235 degrees centigrade.
235 to 315 degrees centigrade.
Above 315 degrees centigrade.

Reports are to be made on individual fractions. In making such reports it is to be distinctly understood that these fractions do not necessarily refer to individual compounds. In other words, the fractions between 210 and 235 degrees will not necessarily be all napthalene, but will probably contain a number of other compounds. The distillation should be a continuous one, and should take about forty-five minutes. When any measurable quantity of water is present in the oil, the distillation should be stopped, the oil separated from the water, and returned to the retort, when the distillation should be recommenced and the previous readings discarded. In obtaining water-free oil, it will be desirable to free about 300 to 600 cc. of the oil by using a large retort and using 100 grammes of the water-free oil for the final distillation. In the final report as to fractions a correction must be made of the amount of water remaining, so that the report may be made on the basis of a dry oil.

REPORT OF SUB-COMMITTEE ON BITUMINOUS PAVING SPECIFICATIONS.

Your Sub-Committee on Bituminous Concrete Paving prepared a report for submission to the meeting of the Society in Boston during October, 1914, which consisted of a modification of the previously published specifications of the A. S. P. S. for bituminous concrete. At a session of the committee held before the meeting of the Society it was suggested that an effort be made to clear up the question as to whether or not the proposed specification was an infringement of the patents held by the Warren Brothers Company, on what is known as the Bitulithic pavement. Several sessions of the sub-committee were held, and at least one session of the General Committee, to discuss the subject, at which a representative of the Warren Brothers Company was present. It was decided the most effectual method of procedure was to endeavor to come to an agreement with the Warren Brothers Company and submit two specifications, one of which should be the Bitulithic specification and the other a non-infringing specification for a bituminous concrete pavement which your sub-committee could recommend as in keeping with good practice. This, in effect, was the understanding your sub-committee had of its instructions. As it was recognized no report along these lines could be agreed upon and presented to the meeting of the Society then in session, the representative of the Warren Brothers Company, Mr. George C. Warren, was requested to take a copy of the tentative report of the sub-committee for his consideration and to suggest such modifications thereof as his company would be willing to agree do not infringe the Bitulithic patents, with a view to having both specifications, that is, the Bitulithic and the open or non-infringing specification, adopted by the Society.

In response to this request a letter was received by the sub-committee from the Warren Brothers Company, dated February 6, 1915, setting forth at length their position on the matter. Without embodying the letter in full in this report, which seems hardly necessary, the following paragraph quoted from the letter seems to sum up pretty clearly their position:

"In order that you may further appreciate the broad scope of all our patents with respect to combinations of mineral aggregate and bituminous materials and that you may better appreciate the basis of the statement made above, that we believe our patents cover everything which can be devised as an improvement on standard sheet asphalt (in which we include 'Topeka') and the 'open mixture,' we could call your particular attention to several of our 30 patents, coverings methods, processes, apparatus, manufacture of bitumen and resulting pavements, etc."

In view of so great breadth of claims, which was further amplified in the letter quoted from, your sub-committee did not consider anything would be accomplished by continuing the discussion, which must have been done by letter, and consumption of much time, as all parties were widely separated.

Your sub-committee, therefore, abandoning, for the present at least, the attempt to reconcile the patent claims of the Warren Brothers Company and the opinions of engineers who are disposed to dispute the universal application of their claims to all good bituminous concrete construction, beg to submit the following, which is a revision of the specifications adopted by the Association for Standardizing Paving Specifications at their meeting February 24-28, 1913.

It is proposed to abandon the use of two distinct specifications designated as "X" and "Y" because of the slight differences between the two in most respects and the confusion resulting from issuing two standard specifications, both termed Bituminous Concrete. There are, however, two gradings of mineral aggregate presented, designated as "X" and "Y," either of which may be consistently used with the rest of the specifications.

It is our understanding that the term Bituminous Concrete is properly applied to any mixture suitable for paving purposes, composed of broken stone, sand (or other fine mineral matter) and bituminous cement, mixed together before being laid, and which is laid while in a plastic condition. To this description, to be consistent with the definition of Bituminous Concrete adopted by the Society, should be added "there must be stone enough in its composition to form an important part thereof and add to its strength and durability."

The following specifications have been drawn up in accordance with this definition.

It is our belief that bituminous concrete may be successfully used as a paving material under a great variety of conditions and traffic; that it is adapted to use on a standard concrete base and on a well constructed macadam base, either new or old, and therefore finds an especial field in providing a permanent wearing surface for old macadam.

In the preparation of these specifications we have endeavored to recommend only methods, proportions and materials that have been tried and proved successful under a variety of conditions. For this reason only the bituminous cements have been considered that retain approximately their original consistency after going through the process of mixing and laying and are permanent in quality thereafter, excluding from consideration in this connection emulsions, oils volatile in character, and cements softened with light fluxes so that they may be worked cold or at low temperatures. Thus the cements specified are practically solid at ordinary atmospheric temperatures and require to be heated and mixed with the stone and sand while they are hot. The processes specified require the use of standard machinery in which the bituminous cement is not exposed directly to the action of fire during the process of mixing.

In these particulars we have endeavored to be conservative, believing there is danger in offering anything but tried and proved materials and methods in a standard specification.

We do not consider that the following specifications should be used in their entirety exactly as written in any case, as the effort has been made to produce specifications general in character which may be adapted to varying conditions of traffic. Thus the extreme range of penetration for asphaltic cement has been made from 40 to 85 which is too wide a range to admit for any particular case. A penetration of 40 will give a hard and stable pavement, while 85 will give a pavement too soft for heavily traveled streets. The choice should be made to meet conditions and the specifications applying to any particular case drawn closer within the limits named for penetration, working temperatures, etc. The engineer in charge should secure complete reliable analyses of the bituminous cements he contemplates using from chemists making a specialty of bituminous products and compare them on all important points, not considering the same necessarily satisfactory because the results come within the limits specified.

Asphaltic cements made from both natural and manufactured asphalts come within the requirements of the following specifications.

Your committee has offered, as stated above, two gradings of the aggregate designated for convenience as "X" and "Y," between which the engineer should make choice before presenting the specifications to bidders.

It is not attempted to pass upon the validity of certain patents that have been issued for pavements, and the various municipalities that may adopt grading "X" are advised to determine their own policies as to the recognition of such patents.

Grading "Y," however, we believe provides for a construction about which there can be no question raised of patent infringement.

Respectfully submitted,

LINN WHITE,

Chairman, Committee on Bituminous Paving.

SPECIFICATIONS FOR BITUMINOUS CONCRETE PAVEMENT.

RECOMMENDED BY THE SUB-COMMITTEE ON STANDARD SPECIFICATIONS FOR BITUMINOUS PAVING.

[These specifications have not been adopted, but are printed for information and discussion at the convention at Dayton, Ohio, Oct. 11-15, 1915.]

SUBGRADE.

The contractor will be required to do all of the grading necessary to bring the surface to the proper subgrade as determined by the lines and grades given by the engineer. If the material at subgrade is of an unstable character and unfit for foundation the contractor shall make such additional excavation as may be determined by the engineer and refill with approved material. After all necessary grading has been done to bring the surface to subgrade, the street shall be thoroughly rolled with an approved road roller, weighing not less than 10 tons. If settlement occurs the depression shall be filled and then re-rolled until the surface is solid, uniform and parallel with the grade and cross section of the finished pavement. All filling shall be free from animal or vegetable matter and of a character approved by the engineer. In cases of spongy or yielding subgrade some other means besides ordinary rolling and sprinkling must be employed to obtain satisfactory compaction of the subgrade. In the case of loose, sandy soils a small amount of cinders, gravel or fine crushed stone spread over the surface will often put it in a condition to be compacted under the roller. In the case of clay soils that puddle up and wave or creep under continued rolling it is best to roll as dry as possible and to be sparing in the use of water when rolling the first layer of macadam. Cinders, gravel or stone screenings will often help in rolling such subgrades.

SUB-DRAINAGE.

When the soil is of such a character that it retains an excessive amount of moisture, such as clay subject to swelling or

heaving under the action of frost, or sands similar to quick sand that do not afford a ready natural drainage, sub-drains should be provided.

These may be of two general kinds; first, tile drains of open porous material or vitrified tile laid with open joints; second, trenches filled with broken stone, gravel, cinders or other similar material.

In some cases it may be sufficient to construct a sub-drain on each side of the roadway at or near the lines of the gutters, but when the soil is of a very wet nature it may be advisable to lay additional lines of drains which may be in or near the middle of the roadway. This system of drains may be varied by diagonal lines of drains running from near the crown of the roadway to the gutters.

In all cases the drains should have connections with the existing sewers, catchbasins or inlets.

New Macadam Foundation.

If the pavement is to be laid on a new macadam foundation or base the latter shall be built as follows:

The total thickness of the macadam base will vary according to character of soil, drainage, kind of stone available, etc. In general, the macadam base should be constructed of broken stone which is sound, hard and durable under traffic. The broken stone should be separated into different sizes by screening, the smaller sizes with the dust being used to fill and bond together the larger sizes. The thickness of the base should be regulated by experience in constructing ordinary waterbound macadam roads in similar situations, the total thickness of pavement, including wearing surface, being made the same or a little less than well constructed macadam.

After the subgrade has been properly prepared, spread a layer of clean stone passing a three (3) to three and one-half ($3\frac{1}{2}$) inch revolving screen and held on a two (2) inch screen to a depth sufficient when thoroughly rolled to form about two-thirds ($\frac{2}{3}$) of the total thickness of the base. The thickness

of this layer should be regulated by laying on the subgrade at proper intervals cubical blocks of wood of the proper dimensions to give the desired thickness. Over this layer of stone spread with shovels stone screenings in sufficient quantity to fill the voids between the larger stone. The screenings should be spread gradually and thoroughly rolled with a road roller weighing at least 10 tons during the process of spreading the screenings. As the screenings are worked into the coarse stone under the roller, more should be added here and there where voids appear. At first the rolling should be done dry until the stone appears to be well filled, then the surface should be well sprinkled and again rolled, the rolling and sprinkling continued until the layer of stone is thoroughly compacted and no more screenings can be forced in. Just enough screenings shall be used to fill and bond the stone, leaving no surplus screenings on the top.

The above method may be varied by using the crusher run of stone without the addition of any other filler where the small sizes are not in excess. Also a filler other than stone screenings, such as bank gravel or sand, may be used in some cases where experience with the materials available shows better results can be obtained. Under some conditions the character of soil and stone available may be such as not to require the use of any filler with the stone of the first course. The specifications given, however, represent the best average practice where stone with bonding value, such as limestone or trap rock, can be obtained.

When the first layer of macadam is completed as specified, spread a second layer of clean stone passing a two (2) or two and one-half (2½) inch screen and held on a one (1) inch screen to a depth sufficient when thoroughly rolled to form the remaining one-third (⅓) of the total thickness of the base. Over this layer of stone spread evenly with shovels stone screenings and roll with the application of water by sprinkling. The sprinkling and rolling shall be continued until the stone is well bonded and until no more compression can be observed

under the roller. Just enough filler should be used to accomplish this purpose and not enough to form a layer or film over the surface of the stone. It is better not to fill the stone quite flush, leaving the coarse particles of stone slightly projecting, so as to have a coarse, grainy base upon which to put the wearing surface.

As an alternate method of construction the macadam may be well filled with screenings, watered and rolled until flushed up smooth. Over the surface of the macadam base thus constructed shall be spread a layer of clean stone of a size to pass a two (2) inch ring and be retained on a one (1) inch ring. This layer of stone shall average one and a half ($1\frac{1}{2}$) inches or practically only one stone deep and is for the purpose of forming a binder or key between the base and wearing surface and thus preventing lateral displacement of the surface. After being spread evenly it shall be lightly rolled, only enough to partially imbed the stone and set them firmly in place without crushing or forcing the fine material up from below to fill the surface voids. The final rolling should be done while the macadam base is still moist and comparatively soft.

The thickness of the pavement, including base and wearing surface, should vary according to local conditions and should be fixed by the engineer in charge when all the varying conditions of soil, drainage, traffic and materials of construction are understood. In general, a thickness of macadam base of eight inches with a wearing surface of two inches will be enough for any except the most adverse conditions, and a base of four to four and one-half inches with a wearing surface of from one and one-half to two inches will meet the most favorable conditions of firm, unyielding soils and light traffic.

Old Macadam Foundation.

If the pavement is to be laid on an old macadam foundation, the surface shall be thoroughly swept and cleaned of all fine material that may be caked upon the surface of the stone

or lying loose as dust, thereby exposing the clean, coarse stone for the reception of the bituminous concrete.

If the old macadam does not present the desired coarse, grainy surface, or is not at proper and satisfactory grade after cleaning, it shall be spiked up and redressed to the desired crown and grade, the coarse stone being brought to the top by harrowing or otherwise, or new stone added where needed. It shall then be watered and rolled until thoroughly compacted. If the result is not the required coarse, grainy surface, a layer of clean stone shall be spread and lightly rolled as described above in the paragraph relating to new macadam foundation.

Concrete Foundation.

When a portland cement concrete foundation is used, it should be laid according to the standard specifications adopted for concrete foundation. The surface, however, should be roughened to form a key for the wearing surface. This may be done by using coarse stone of fairly uniform size and laying the concrete fairly wet, or by brooming, washing with a hose before hard set, tamping with grooved rammers, or by spreading a light layer of coarse, clean stone over the fresh concrete and lightly tamping.

Curb.

If a curb or curb and gutter is used, the face against which the paving material will be laid shall be painted with a coat of hot bituminous cement in advance of the pavement.

A curb or curb and gutter should be used in all cases of a street devoted to miscellaneous uses and where there is occasion for many vehicles to stop at the curb line, but in the case of a park driveway or a suburban highway a bituminous concrete pavement may be successfully used without a curb. No other protection for the edge of the pavement is required except to provide a coarse, grainy base into which the paving material is rolled.

Wearing Surface.

On the foundation, as heretofore specified, shall be laid the bituminous concrete wearing surface, which shall consist of a mineral aggregate mixed with bituminous cement and laid as hereinafter specified.

This wearing surface shall have a thickness of ... inches after thorough compression with a roller.

For heavy traffic a thickness of two (2) inches is sufficient for all practical purposes and in some cases will afford more stability than a greater thickness.

For moderate and light traffic one and one-half (1½) inches will be sufficient thickness for the wearing surface when laid on a well-constructed base, as specified above.

Mineral Aggregate.

The mineral aggregate shall consist of a mixture of broken stone and sand, to which shall be added as required stone, dust or portland cement.

Any sound, durable stone, either trap rock, limestone or granite, usually considered suitable for macadam, may be used. It should be broken as nearly cubical as practicable. It should not show distinct planes of cleavage or crystalline faces and should not readily crush or split under the roller when being rolled in the pavement. Between two kinds of stone, choice should generally be made of the one showing absorption; such as is shown by the better grades of limestone, is a desirable quality, as the bonding strength of the cement is somewhat improved thereby.

The sand shall be hard grained, moderately sharp, free from loam or other foreign material and varying in size from that passing a one-quarter (¼) inch screen to dust passing a 200-mesh screen. There shall not be over 5 per cent. by weight passing the 200-mesh screen and there should not be over 20 per cent. held on the 10-mesh screen.

Dust in the form of finely ground limestone or portland cement may be added to the mixture, but in such quantities

that the screenings of the total ingredients entering into the mix shall in no case show over eleven per cent (11%) by weight passing a 200-mesh screen.

The proportions of the various ingredients composing the Bituminous Concrete shall be approximately as follows:

Grading "X."

Bitumen	6 to 9%	by weight
Dust passing a 200-mesh screen	7 to 11%	" "
Mineral matter passing a 80-mesh screen	8 to 15%	" "
" " " " 40- " "	10 to 20%	" "
" " " " 10- " "	5 to 10%	" "
" " " " ½-inch "	40 to 60%	" "

The last named size of material may be of one size screened stone or may be of crusher run, or may be increased from that passing a ½-inch screen to that passing a ¾-inch screen if the use of a coarse stone is found more expedient. Preference, however, is given to the smaller size because it makes a more uniform product and the particles are not so liable to be separated in handling as with the larger size stone.

Grading "Y."

In lieu of the above specified grading, the following, designated as "Grading Y," but coming within the limits of what is commonly known as the "Topeka Specifications," may be substituted:

Bitumen	7.5 to 10.5%
Passing 200-mesh screen	7. to 11. %
" 80- " "	8. to 26. %
" 40- " "	11. to 37. %
" 10- " "	8. to 26. %
" 4- " "	8. to 22. %
" 2- " "	Not more than 10%

The minimum amount of bitumen allowed in either grading shall only be used in mixtures containing the minimum total passing the 80-mesh. The percentage of bitumen must be increased above the minimum as the total passing the 80-mesh increases.

(c) By resolution of A. S. M. I. Convention held at Dayton, Ohio, October, 1915- "Grading X" herein tentatively reported was dropped "Grading Y" was modified. The Bitulithic specifications and the modified Topeka specifications as adopted by the 1915 Convention are inserted at page 828.

The item designated as Dust includes in addition to the portland cement or stone dust that may be added, fine sand passing a 200-mesh screen not exceeding 5 per cent. of the total mixture and such 200-mesh mineral dust self contained in the refined asphalt.

Method of Mixing.

The aggregate shall be dried and heated in properly designated driers before mixing with the bituminous cement. The driers shall be of the revolving type, thoroughly agitating and turning the materials during the process of drying. When the aggregate is thoroughly dried and heated to a temperature of from 200 to 350 degrees F., depending upon the bituminous cement used, it shall be immediately before cooling or exposure to moisture, mixed with the hot bituminous cement as hereinafter specified. If stone dust is used it shall be introduced directly into the mixer without passing through the drier.

The bituminous cement shall be melted in a tank arranged so the heat can be properly and easily controlled and regulated. When melted and raised to a temperature of from 200 to 350 degrees F., depending on the bituminous cement used, it shall be combined in the proper proportions with the hot aggregate and immediately mixed in a properly designed mixer with revolving blades until a thorough and intimate mixture of the ingredients has been accomplished, and the particles composing the aggregate evenly and thoroughly coated with the bituminous cement. The mixer shall not be exposed directly to the action of fire.

Method of Laying.

While still hot from the mixer the paving mixture shall be spread evenly on the foundation with hot iron rakes and shovels, so that when compressed with the roller it shall have the thickness specified, with the surface even and true to grade. Along the curb and around manholes, catchbasins and other obstructions in the street, where the roller cannot reach,

the compression shall be secured by the use of hot iron tampers. The rolling and tamping shall be done as quickly as possible after the material is spread, while still hot and pliable. When the paving mixture is hauled on the street in dump wagons it shall be, when ordered by the engineer, kept covered with canvas to retain heat, dumped on platforms and shoveled into place and raked to the proper grade. As soon as spread the paving mixture shall be rolled with a tandem road roller weighing at least five (5) tons and the rolling continued, working lengthwise and diagonally of the street. When practicable additional compression in the wearing surface should be secured by the use of a ten-ton roller. Rolling must be steadily kept up and continued until all roller marks shall disappear, and the surface gives indications of no further compressibility.

The paving shall be done continuously, so the number of joints between the hot and cold material may be reduced to the minimum. When it is not practicable to lay it continuously and a joint is unavoidable, the edge of the cold material shall be trimmed down to a rough feather edge, and the surface, where the joint is to be made, painted over with bituminous cement, the hot material raked over the feathered edge and thoroughly rolled. Instead of trimming the cold material, joint strips may be used consisting of strips of canvas about eighteen (18) inches wide with three parallel lines of three-quarter (¾) inch ropes sewed on the under side about three (3) inches apart. The joint strips shall be laid on the feather edge of the freshly-raked material with the upper rope at the line where the thickness begins to decrease and the rolling completed on top of the canvas as for finished pavement. The faces of the curb and gutter, iron castings, etc., shall be painted with bituminous cement before the paving mixture is laid.

Surface Finish.

As soon as possible after the rolling of the mixture is finished, and while the surface is still fresh and clean, and, if possible, while warm, a seal coat of bituminous cement of

proper consistency to be flexible when cold shall be spread over the surface. It shall be applied while at a temperature of from 200 degrees to 350 degrees F., depending on the bituminous cement used, and evenly spread with rubber squeegees or mops. Only a sufficient coat shall be spread to flush the surface voids without leaving an excess. Immediately over this a top dressing of torpedo sand, fine gravel or stone chips free from dust, which must be thoroughly dry and heated in cold weather, shall be spread and thoroughly rolled into the surface. A small surplus shall be left to be worn in or worn away by the traffic.

In the case of park drives and roadways, not subjected to heavy, constant traffic, and where a more grainy and coarse surface is desired, the surface finish specified above may be omitted and the following method of finishing adopted.

As the bituminous concrete is raked to grade, and just before the roller comes on it, spread dry stone chips or torpedo sand evenly with swinging motions of a shovel, until the surface is barely covered. Then roll thoroughly as specified in the preceding paragraph relating to method of laying. If bare spots appear under the roller, sprinkle more chips or sand and continue the rolling until the whole surface is fairly covered.

After the sand or stone chips have worn into the surface the street shall be swept, all excess of surfacing material removed and the street left clean.

Asphaltic Cement.

The asphaltic cement may be prepared from the following asphalts combined with flux as hereinafter specified, if flux is necessary: (1) From refined natural asphalt; (2) from the residue obtained in the careful distillation either with or without oxidation of asphaltic or semi-asphaltic petroleum; (3) from any uniform combination of the preceding materials together with a suitable flux, if flux be necessary, such combination being subject to the approval of the engineer.

Each bidder must state the nature and origin of the bitumen to be used by him, and further, shall submit samples of the bituminous cement with his proposal.

The asphaltic cement shall pass the requirements designated below:

(1) It shall have a penetration of from 40 to 85 at 77 degrees F., depending upon the traffic and climatic conditions and hardness of the pavement desired. A penetration of from 40 to 50 in most cements will produce a hard, exceedingly stable pavement which should be used on streets subjected to constant or heavy traffic.

A penetration of from 50 to 65 in most cements will produce a pavement best calculated to meet general traffic conditions The above penetrations are measured in hundredths centimeters with a No. 2 needle weighted with 100 grams acting for 5 seconds.

(2) When 50 grams of the cement are maintained at a temperature of 325 degrees F., for five hours in a tin box 2¼ inches in diameter by 1¾ inches deep, there must not be volatilization of more than 5 per cent. by weight of the bitumen present nor shall the original penetration be reduced thereby over one-half.

The method of test employed is that recommended by the Committee on Coal Analysis of the American Chemical Society.

(3) Of the bitumen of the asphaltic cement which is soluble in carbon disulphide 98½ per cent. shall be soluble in carbon tetrachloride. In this test for carbenes the asphaltic cement to be tested should be allowed to stand over night, covered with purified carbon tetrachloride. The test to be performed in subdued light.

(4) The cement shall not flash at a less temperature than 350 degrees F., New York State Closed Oil Tester.

Flux.

Use the flux specifications prepared by the Committee on Asphalt Pavement Specifications.

Coal Tar Cement.

The coal tar cement shall be residue of the distillation of coal tar only, and shall be refined for the special purpose of making a paving cement.

No mixture of hard pitch with the lighter oils of coal tar will be permitted.

Its specific gravity shall be not less than 1.20 nor more than 1.29 at 69 degrees F.

The melting point determined by the cube method shall be not less than 100 degrees F. and not more than 115 degrees F.

It shall contain not less than 15 per cent, nor more than 30 per cent. of free carbon insoluble in benzol.

It shall be free from water as determined by distillation and shall show upon ignition not more than ½ per cent. of inorganic matter.

No distillate shall be obtained lower than 338 degrees F. and up to 600 degrees not less than 5 per cent. and not more than 20 per cent. of distillate shall be obtained. The distillate shall be of a gravity of not less than 1.03 at 60 degrees F. The residue shall have a melting point of not more than 165 degrees F. In making this distillation an 8-ounce glass retort shall be used and the thermometer suspended so that before applying the heat the bulb of the thermometer is one-half inch above the surface of the liquids. The melting point of the pitch shall be determined by suspending a ½-inch cube in a beaker of water one inch above the bottom. The temperature shall be raised 9 degrees per minute from 60 degrees F. The temperature recorded the instant the pitch touches the bottom shall be considered the melting point of the pitch. In testing the original materials the initial temperature shall be 40 degrees F.

Water Gas Tar Cement.

1. The specific gravity at 25 degrees C. shall be between 1.155 and 1.170.

2. On extraction with cold carbon disulphide at room temperature for 20 minutes not less than 97½ per cent. shall be soluble.

3. When tested in a penetrometer at 25 degrees C. with a No. 2 needle under 100 grams load for five seconds, it shall have a penetration of not less than 27.5 m.m. and not more than 32.5 m.m.

4. When 100 c.m. are distill in a 250 c.c. Engler flask according to the method proposed by the American Society for Testing Materials, the loss by weight shall be within the following limits:

From Start to 170 degrees C.	0
170 to 225 " C.	not over ½%
225 to 270 " C.	from 2 to 6%
270 to 300 " C.	from 5 to 9%
Residue	not less than 84%

BUSINESS PROCEEDINGS

OF THE

Twenty-first Annual Convention of the American Society of Municipal Improvements, held at the Somerset Hotel, Boston, Mass.

TUESDAY, OCTOBER 6, 1914.

MORNING SESSION.

The Convention was called to order by President Christ at 10:30.

THE PRESIDENT: Gentlemen of the Convention, I take great pleasure in introducing to you the Honorable James M. Curley, the Mayor of this beautiful City of Boston, sometimes called the "Hub of the Universe." (Applause.)

THE MAYOR: Mr. President, Ladies and Gentlemen: Boston is exceedingly grateful to your organization for having selected our city as the place for holding your convention.

Boston is confronting the same problems that all American cities are confronting today, but in our case, perhaps they are more difficult of solution than in the case of some of the newer cities of the West, Northwest and certain sections of the South. We find that every city in the entire United States, substantially, must consider its street surfacing problems from a different standpoint. Climatic conditions here make it difficult, if not impossible, to adopt the system that is proving such a success in certain of the Western cities and in New York, in the matter of the cleaning and flushing of streets. We have 500 miles of streets, 320 miles of which may be termed dirt construction, which in the spring time makes it a matter of difficulty to cross, and during the summer time resembles the Sahara Desert in the matter of dust. We are meeting the problem with some degree of courage and hope of

solution. We believe the health of the community in large measure is dependent upon the condition of the surface of the public street, and an organization such as yours, dedicated to municipal improvement along sanitary lines is an organization deserving of the support of every citizen. We are glad to have you here because we know you can contribute to the future of our city.

Boston today occupies a singularly fortunate position in American municipalities. We have the largest, and we believe the best park system in the world. In the matter of public health, thanks to our system of sewerage, water supply, of street surfaces such as they are, and our climatic conditions, Boston has the lowest death rate this year, per thousand of population of any city in the United States, and we hope to make it of any city in the world. We appreciate that a body of the character of this association, contributing their ideas to our engineering force, and by the interchange of ideas, will help us to solve our problems, and that such an organization is deserving of the right kind of welcome from the Chief Executive and the people of what we consider the best city in the entire world—Boston. (Applause.) We appreciate, and we trust the public generally will realize the value of your contribution to public health and public progress. We appreciate the opportunity that is ours in having you here, and our only regret is that your stay will be so short. We would like to have you remain with us the entire month, if that were possible. We are glad you are here during the time when Nature in our parks is at her best, when the climate is most pleasant, and when our home team, we trust, will win the championship in baseball. (Laughter.)

We are installing at present a high pressure water system which during the next three years will be laid through fourteen miles of downtown streets, and it is our aim that in every place where a foot of water pipe is laid, the upper surface shall be of sanitary and durable construction, either wood block or grouted cement with granite block—or bitulithic.

(Laughter and applause.) We are getting away from the idea that the cheapest method is the best. We believe the householder who invests money in those necessities that contribute to the beauty of the home, rugs and carpets, is entitled to consideration, and that in a progressive municipality the day should have passed when, because of the character of work done by the public works department, the rugs and carpets should be tracked with oil spread upon the streets. We believe the spraying of the streets with oil is not conducive to the public health, and certainly not conducive to good temper, and the sooner it disappears in our community the better we will be pleased. It is our aim this coming year to lay 25 miles of granolithic sidewalks, and we propose doing that each year for four years. It is our aim to lay ten miles of durable street surface, sanitary in character, each year during the next four years, and if this policy is continued, and your organization sees fit ten years from now to make Boston your convention city, we will show you the results of concentrated effort in the right direction for the benefit of the entire people.

We are gradually making changes in our fire department. We are gradually working away from the old theory that fires can be fought successfully by newspaper articles and horse-drawn vehicles. It has been brought home to us frankly that the best way to fight fire is to reach the scene of the conflagration before it makes headway, and then give it all the water it will take. So we are gradually motorizing our entire fire department, and we trust in the next five years to have it entirely motorized, and we believe we can do it without spending a dollar more than is necessary at present for maintenance; in other words, we believe we can do the work out of our maintenance appropriation. Now a fire alarm comes in, and every piece of horse-drawn apparatus that goes to the fire requires that the driver of the engine shall take care of his horses, the driver of the hose carriage of his horses, the ladder truck and the chemical drivers the same, so that one-sixth of the fire department is out of commission at the scene of the fire. By

installing motor apparatus it will be possible to develop a higher degree of efficiency at one-sixth less cost.

We are working along lines of progress in the matter of our subways and in the installation of larger water mains throughout the city, not only to benefit public health, but for the protection of life and property. There never could have been a better time for your Society to visit us. We are developing new fields of thought, of effort and of direction in every one of the city's activities. We will contribute to your organization the heads of our various departments during your stay here, that they may have an opportunity to advise with you, to be of benefit to you, and in return to receive the benefit that comes from the interchange of ideas between men who do things for the good of humanity. (Applause.)

The President: I am somewhat surprised that they know about bitulithic here in Boston, considering that Mr. Warren lives here. (Laughter.) We have with us today a gentleman who is engaged in work we are all interested in, and from whom I know we shall all be glad to hear, Col. William D. Sohier, Chairman of the Massachusetts Highway Commission, and also President of the Highway Association. (Applause.)

Col. Sohier: Mr. President and Gentlemen: You began with our best municipal improvement, the Mayor, and I think you must realize since you have heard him talk that the City of Boston is progressing along the lines you are helping us to progress in. An association devoted to municipal improvement is very much needed in this country.

What we especially need in Boston is something that some of you gentlemen have—city planning. Some of you come from cities where every time they lay a water pipe, or put in a telephone line or an electric light, you do not have your pavements dug up. In the City of Boston last year there were 150,000 permits issued for opening up the streets, and you will realize something should be done in the way of saying that when pavements are once laid, they must not be imme-

diately dug up and ruined. Those things should be laid under the sidewalks or down the alleys. I don't know whether our department can do much for you, but we shall be very glad to show you the work we are doing. We cannot claim in Massachusetts that we are doing as much work as is being done in several other states; we haven't spent nearly as much money on state highways and improved town-ways in this state as has been spent in many other states. But if we have anything to our credit, it is that when we have spent ten million dollars, as we shall have spent next year, on state highways, running over a period of twenty-two years, you can go over any of our state highways today, and find you have a good road to travel on. And in some states, when they spend a hundred millions, you can go over some of their highways, roads that have been built over three times in the last eight years, and you haven't a good highway now to travel over. And I should like to ask this association why it is? And whether what you really need is not to get efficiency and economy, by keeping in office, as our present Mayor has done, the efficient heads of departments, and utilizing the knowledge and the experience those men and the men under them have got in road building, rather than changing with each change of administration. We get letters from many states, saying they understand we have a good system for building highways in Massachusetts, and asking to know about it. They are generally criticising a department already existing, but which has not been going long enough to know what the job is. New York state educated some men six or seven years ago, and put them in charge of sections six miles long. It takes us about two years to educate these men, so that they will fill a hole before it is a hole. When a stone shows through a tar or an oil surface, they will paint it before it gets to be a pot-hole. And if they find a pot-hole, they mend it before it forms a mound and becomes two pot-holes. When we get those men educated, they stay; but in New York and some other places they go with the change in administration. That costs the municipalities and the states

more than anything you can conceive of. If you have an engineer who knows his job, who knows how to build a road, he knows the difference between gravel and clay and loam, and he knows when he has a material that will make a road, and uses it, and then you have some one who is worth a great deal to you in building roads. When our young men come to us from the Civil Service Commission, they do not know that, and we have to teach them. And sometimes, as this year we are doing, we have to take up a thousand feet of road, simply because the engineer, when his men were idle, having run out of gravel, went to a bank of clay and used that instead of the gravel. We must throw that away, and it costs more than his salary for a long time. When you educate your men you should keep them, and when you educate the workmen, keep them. When you have a good department, educated at the expense of the public, the public is entitled to get the returns from it. I think you could do a great deal, as I have no doubt you are doing, in the line of seeing that the men in charge of the public works are efficient, men who learn their job, and when they learn their job, see that they stay on that job, and give the public what the public is entitled to receive, the result of the education they have got at the expense of the public. If we have a man who puts a poor tar or oil on the roads, and the roads go to pieces the next year, in three days perhaps we lose $3,000 for the state, and if we put a man in that position who doesn't know tar or oils, we will have trouble.

I see some of you gentlemen looking at me, and I will say that if any of you gentlemen can tell us how to tell a good bituminous material from a poor one on the job, a bituminous material that will wear, and that won't get bad in the first two or three years, and worse the fourth year, we shall consider it a very great favor. For we can show you a lot of that sort of material, sold by gentlemen in this convention. Each gentleman comes along each year, and says "I have good material." They want to get good material; they don't want to

sell us material that isn't good. They have their laboratories, and some of them have made successes right along; the others are changing. Some oils were bad four years ago, and so far as I know they are good today. I hope four years from today they will have proved to be good. If you can tell us how, when we buy material and pay for it, and add 33 per cent. to the cost of building the road so that it will stand without much maintaining, whether it is good or bad, by anybody on the job, you will be saving more money for the United States than in any other way I know of.

I am very glad you gentlemen came here to Boston. We want to know what you know and we don't know. We will be glad to show you anything we know and you don't know. We shall be very glad to show you the various types of our roads; we cannot show you pavements, because we do not build them. We are working now in over 200 of our 300 towns. The best work we are doing is in helping these towns to help themselves, in teaching the countryman how to build a road with his own material, and seeing that he does it. And we have more miles of good road in Massachusetts built in that way, by what you might call state aid, than we have in our state highway system. We have some 300 miles where we have improved gravel roads out of automobile fees, and the automobilists have received the benefit from them in the saving in tires, gasoline and repairs. We shall be glad to show you any type of construction we have been doing, bitulithic, bituminous, with tars and asphalts, macadam road grouted with sand and tar, which you may not have seen, based on Liverpool specifications, concrete roads, and various constructions of that sort. I thank you very much. (Applause.)

The President: I will now call upon our genial Third Vice-President, Mr. Sprague, to respond on behalf of the Society to these very cordial welcoming addresses.

Mr. Sprague: Mr. Mayor, Col. Sohier, Mr. President, and Gentlemen: I appreciate highly the honor the President has

bestowed upon me this morning, nor am I insensible to the responsibility of replying to such addresses as we have listened to, from His Honor, the Mayor, and Col. Sohier of the Massachusetts Highway Commission. Being a Bostonian, it would not become me to contradict anything said by either of the speakers. The situation I find myself in this morning is something like what happened at the end of a certain vaudeville act. The act was put on by a man and a woman. The lady in the act was no longer young and fair to look upon. The man in the act bound her hand and foot to the partition, and then stood some distance away and threw knives at her or about her. The first knife thrown stuck into the wall, barely grazing her head, and as it hung in the partition, quivering with its force, somebody in the audience exclaimed, "My God, he missed her." (Laughter.) There is no more fitting city or a better city for this Society to visit than Boston, and, gentlemen, I speak from experience. Boston is the center of a great many engineering and civic improvements. It has shown the country how to solve problems of water front improvements, dock developments, transportation facilities, sewerage, water supply; in fact, the City of Boston has made nine-tenths of the civil engineers of the country. This American Society of Municipal Improvements, Mr. Mayor and Col. Sohier, was organized some twenty-one years ago for the purpose of studying questions relating to municipal engineering. We meet in different cities each year, and these various municipal problems are discussed in all their phases. Boston is the pioneer in the art of road construction, and in sewage disposal matters. The Massachusetts State Board of Health, by its researches and investigations, is known throughout the world. And so I say there is no better place to which this Society could come for its annual convention. We know our stay here will be profitable. We regret also that the time is so short. We feel confident that, had we time, a month would not be too long for an inspection of the magnificent improvements being made here, and we trust it will not be long before this convention again meets in the City of Boston. We thank you. (Applause.)

THE MAYOR: We have arranged a municipal exhibit of the city's activities in conjunction with the Food Fair being held in Mechanics' Building. The exhibit would be interesting to the members of this organization, and I shall be pleased to send tickets to you here for your use. It is our purpose to have nightly addresses by men in charge of the various departments of the municipality, so that the administration of the city may be brought more closely or more directly to the attention of the public who pay the bills. (Applause.)

THE PRESIDENT: The next thing on the program is the President's address.

PRESIDENT'S ANNUAL ADDRESS.

EDWARD H. CHRIST.

At this Twenty-first Annual Convention, The American Society of Municipal Improvements reaches its majority. I know of no more appropriate place to celebrate the same, than in this beautiful and historical city.

It is hardly necessary to extol the youthful exploits of this Society. It is too well known by its deeds of the past to need further words. The amalgamation of the Association for Standardizing Paving Specifications has given it energy and authority, and it enters upon its manhood with every indication of greatly enlarging and extending its powers for municipal development.

Being the first meeting of the amalgamated societies, the most important subject to come before it will be the adoption of a single set of specifications for street paving. Although the several committees of the two societies have been working in harmony, there are still some differences to be overcome.

It is hoped that the different specifications have been given careful consideration during the past year, and that we shall have a full and free discussion of the same on the floor of this convention, so that the specifications adopted at this meeting

will have the unanimous support of all of the members of the united societies.

It is not expected that these specifications can be copied verbatim, but it is urged that whenever feasible their requirements will be carried out in every detail. By doing so it will be possible to ascertain more easily any defects they may have, and find a remedy therefor.

The standard sewer specifications to be submitted for your consideration, were first presented to the Society at the convention held in Dallas, Texas, in 1912. After a thorough discussion they were returned to the committee with suggested amendments and changes. The specifications as presented and their discussion were printed in the Proceedings.

At our last meeting the modified specifications were submitted. After considerable discussion before the Standard Specifications Committee, they decided not to present them to the Society, but requested that any changes desired by the members be sent to the committee as early as possible, so as to give them ample time for careful consideration. It is hoped that this was done, so that the specifications to be now submitted can be adopted by this convention.

Another very important question to come before you is the report of the Committee on Standard Forms, which will include the reports of the following sub-committees:

Street Paving and Repairs, Street Cleaning and Refuse Disposal, Street Lighting, Sewer Construction and Maintenance, Sidewalks and Curbs, and Uniform Bidding Blanks.

In 1913, the Sub-Committees on Street Lighting, Street Cleaning and Refuse Disposal, and Uniform Bidding Blanks submitted tentative reports, and the lighting blanks and several items of the bidding blanks were adopted.

The submitted forms were printed in full in the Proceedings, so that the members could study them and submit amendments thereto, to the Chairman of the Standards Committee.

The value of these forms was so ably presented by former Secretary Folwell, at our 1912 and 1913 conventions, that they need no further comment from me.

Without a doubt the standardizing of specifications and forms, has done more to advertise our Society than anything it has heretofore done.

But the approval of these is not all that is to be accomplished. We must give them wide publicity year after year and endeavor to have them adopted by municipalities in general. If this is not done I fear it will be but a few years before they are forgotten.

I would recommend the continuance of all of the Sub-Committees on Standard Specifications and Standard Forms, so that they may keep the Society constantly informed of the results of their recommendations; and to suggest any changes therein deemed advisable.

By the program I note we are to have an unusually large number of excellent papers and reports. To give them due and proper consideration it will be necessary for the members to be constant and prompt in their attendance at meetings.

In conclusion I wish to thank the officers and members of the different committees who have assisted me during the past year, and hope that our efforts will result in making our Society larger and better and of benefit and advantage to all municipalities.

The President: We will now have report of Committee on Membership. The chairman is not here, but he has sent his report, and I will ask the Secretary to read it.

REPORT OF COMMITTEE ON MEMBERSHIP.

I wish to express to the Society my regrets at not being able to furnish you with a more satisfactory report as Chairman of the Membership Committee.

The application blanks and list of engineers were received by me late in the summer and unfortunately I was taken sick in July and did not get back into my office until September. In consequence of this, I did not think it advisable to take matters up with the other two members of the committee.

In addition to doing quite a good deal of personal work, I have had printed and mailed out 350 two-page letters, enclosing in each letter the little booklet gotten out by the Secretary and an application blank. Some of these I have heard from personally, and I believe that this little effort will be productive of good.

E. A. KINGSLEY.
Chairman.

THE SECRETARY: A number of returns from the chairman's letters have already appeared, and the attendance from the South and Middle West is gratifyingly large.

THE PRESIDENT: The next will be report of the Committee on Sidewalks, Mr. Lenderink, chairman.

(The report and discussion thereon will be found on page 233.)

THE PRESIDENT: We will now elect a Nominating Committee:

Messrs. Giddings, Schmidt, Folwell, Fisher and Gillen were nominated and elected as the Nominating Committee.

THE PRESIDENT: The next will be the reports of the Secretary and Treasurer.

REPORT OF THE SECRETARY.

CHARLES CARROLL BROWN.

The Secretary presents his report for the first year of his incumbency:

I have attempted to make a balanced list of members, but it has been very difficult on account of the differences in the kinds of members. The following tabular statement will show the condition of the memberships and the changes during the year:

	In 1913	Admitted During Year	Losses During Year	Membership Oct. 1, 1914
Active	323*	38*	5*	339*
Affiliated	4*	3*	..	9*
Municipal	..	30	..	30
Municipal Delegates	..	67*	..	67*
Associate	..	16	9	68
Associate Representatives	87*	19*	13*	81*
Total Individuals (Starred Items)	414	127	18	496

This account does not balance for reasons stated below, the first column containing the Secretary's report of last year and the last column the actual count of members October 1, 1914.

It will be noted that the new class of Municipal Members starts out with 30 cities in the list, 25 of these being from the A. S. P. S. and the others either new members obtained during the year or cities which have been represented heretofore by individual members. Eight of the cities which are members from the A. S. P. S. have not appointed their delegates prior to October 1, the date of this report, and two of them appointed only part of the delegates to which they are entitled for the year 1914 according to the terms of the amalgamation. The dues of the representatives not thus appointed have been paid and remain in the treasury to pay the dues of representatives hereafter appointed.

Three active members have withdrawn and two members have died; nine associates have withdrawn and thirteen representatives of associates, making a total loss of individual members of 18, as compared with 32 lost the previous year. The members who have died are:

Justus Herbert Grant, Special Assistant Engineer, Rochester, N. Y., and S. H. Phelps, City Engineer, Sharpsville, Pa., and their names have been referred to the Obituary Committee for appropriate action of this convention.

The additions to the individuals in memberships have been as follows: 38 active, 3 affiliated, 67 delegates from 22 of the 30 municipal members accounted for above, and 19 representatives of associate members; total, 127.

Membership at present consists of 339 active, 9 affiliated, 67 representatives of 30 municipal members, 81 representatives of 68 associate members. This makes a total of 496 individuals. It is evidently impossible to make the account of memberships and individuals agree since the municipal members are not individuals and the associate members are sometimes firms or corporations which have not appointed any certain individual as their representative. It should be noted that some of the representatives of municipal members were already individual members of the A. S. M. I. This has reduced the list of individual active members 14, so that an individual would not be counted twice. In computing the gain in membership which is really active, the number of delegates of municipal members must be added to the number of the classification active in order to obtain the true number of active members, viz., 406

The increase in membership of individuals, due to the amalgamation of the A. S. P. S. is 53, being the number of delegates of municipal members less the number of such delegates which were already members of the A. S. M. I.

The cities which have not yet appointed delegates are entitled to 32 representatives, dues for this number of representatives having been paid by the A. S. P. S. for one year. These cities are the following with the number of delegates to which they are entitled:

Boston	4	Salt Lake City	3
Chicago	4	South Omaha, Neb.	3
Columbus, O.	4	Lynchburg, Va.	2 additional
Norfolk, Va.	3	St. Louis, Mo.	3 additional
Pasco, Wash.	3		—
Salisbury, N. C.	3		32

The following table will show the monthly receipts during the year classified as to source, and the monthly remittances of the Secretary to the Treasurer. The account closed on September 28, 1914:

		Receipt No.	Proceedings		Specifications	Miscellaneous	Advertisements	Membership Dues					Sent to Treasurer		
			A. S. M. I.	A. S. P. S.				Affiliated	Active	Associate	Municipal	Totals	Dates		Amounts
1913															
Oct.	31	2644-2724	$3.00	......	.....	.....	......	$5.00	$352.50	$165.00	......	$525.50	Oct.	30	$525.50
Nov.	30	2725-2737	6.00	......	$0.25	$67.50	......	......	40.00	20.00	......	138.75	Nov.	30	133.75
Dec.	31	2738-2749	6.00	......	.25	.....	......	5.00	25.00	20.00	......	56.25	Dec.	31	56 25
1914															
Jan.	31	2750-2794	23.00	......	.50	8.68	......	......	60.00	495.00	$460.00	1047.18	Jan.	31	1047.18
Feb.	28	2795-2820	8.00	15.00	.50	.50	......	......	50.00	55 00	......	129.00	Feb.	28	128.25
Mch.	31	2821-2840	22.00	10.00	4.75	.....	......	......	57.50	10.00	5.00	109.25	Mch.	31	110.00
April	30	2841-2855	......	20.00	1.75	.....	......	......	25.00	15.00	15.00	76.75	April	30	76.75
May	30	2856-2862	......	5.00	.....	.....	......	......	25.00	10.00	......	40.00	May	31	40.00
June	30	2863-2910	......	10.00	.....	.....	......	5.00	245.00	......	......	260.00	June	30	260.00
July	31	2911-2929	......	10.00	.25	.....	......	......	77.50	......	......	87.75	July	31	87.75
Aug.	31	2930-2989	48.00	10.00	.75	.....	377.00	......	140.00	......	......	575.75	Aug.	31	575.75
Sept.	28	2990-3024	37.50	10.00	.75	2.50	147.00	5.00	75.00	45.00	10.00	332.75	Sept.	28	332.75
			$153.50	$90.00	$9.75	$79.18	$524.00	$20.00	$1172.50	$835.00	$490.00	$3373.93			$3373.93

There was received $27.00 between September 28 and October 1, which is accounted for as of date October 1, and will be included in the next annual report. Receipts after October 1, including those of the convention, will also be included in next year's report.

The receipts on account of the amalgamation of the A. S. P. S. are as follows: Received from the Secretary of the A. S. P. S. $648.68, of which $460 was for municipal members, $180 for associate members, and $8.68 balance not otherwise assigned. We have sold during the year, volumes of the Proceedings of the A. S. P. S. amounting to $90; the total receipts on account of the amalgamation are therefore $738.68. This should be reduced by $40 of the item of "refunds of dues" in the following account, as this amount was refunded associate members who had paid dues to both Societies.

The receipts during 1914 were greater than the receipts during 1913 by $1,268.28. As above stated, $738.68 of this was due to the amalgamation, and the remainder, $529.60, is the improvement in the condition of the association, due at least in part, to the influence of the combination.

The expenditures classified are as follows:

Office.

Stenographer		$480.00	
Postage		158.52	
Telegrams		4.85	
Expressage		32.08	
Stationery		6.50	
Miscellaneous		1.25	
			$683.20

Printing.

Proceedings, reprints and advance copies, 1913		$983.81	
Cuts and drawings, 1913	$56.71		
Cuts, advance papers, 1914	11.08		
		67.79	
Letterheads, envelopes and billheads		132.20	
Blanks and books of blanks		48.75	
Circulars		69.00	
Programs, 1913		18.00	
			1,319 55

Miscellaneous.

Reporting Convention 1913	$75.00	
Distributing Proceedings and advance copies	134.46	
Ex-Secretary's expenses	64.87	
Committee expense	7.00	
Treasurer's bond	7.50	
Refund of dues	42.50	
Secretary's salary	300.00	
		631.33
		$2,634.08

The total of these expenditures is $2,634.08. This shows a balance of receipts in excess of expenditures of $739.85. The receipts on account of the A. S. P. S. being $738.68, the excess of receipts over expenditures on account of the regular operation of the A. S. M. I. is $1.17, to which should be added $40 of A. S. P. S. dues to associate members refunded, making the real surplus $41.17. The expenditures this year were $433.20 more than they were in the year 1913. This increase in expense is accounted for, first by the cost of reprinting and distributing the report of the Committee on Forms, $187.84, this being done in accordance with instructions of the association, and there being a supply of the report still on hand for future use; second, in services of stenographer, which was probably $200 to $225 more than in the previous year. The volume of business done during the year made the regular employment of a stenographer an absolute necessity, and accounts for the difference.

The following classifications of expenditures may be of interest: Printing and distribution of the report of the Committee on Forms gave rise to the following expenditures, the stationery and office time being estimated as closely as possible:

Printing, etc., on The Rumford Press bill	$91.84
Expressage, to Indianapolis	11.30
Postage	45.00
Envelopes, manila	11.70
Letters, paper, and time on letters	8.00
Sending out 2250, time	20.00
	$187.84

The cost of printing and distributing the Proceedings and the advance papers for 1913, was as follows:

Printing and cuts	$874.92
Sending out	95.57
Advance papers, 1913	50.74
Sending out advance papers	16.32
Expressage	14.03
	$1,051.58

The receipts on account of the Proceedings were:

From advertising	$524.00
From Proceedings A. S. M. I.	153 50
From Proceedings A. S. P. S.	90.00
	$767.50

There is still due from advertisers which will doubtless be collected, $59, making a total for the year $826.50. This shows that the Proceedings cost $225.08 more than the receipts from them.

The Clearing House for Information had the following expenses as closely estimated as possible:

Circular letters, stationery	$5.75
Circular letters, postage	8.50
Circular letters, office time	16.50
	$30.75

The above statements are of course independent of the full statement of receipts and expenditures above given, and possibly will give all the information desired if taken in connection with the classified list of expenditures.

The following members have been admitted during the year 1913-1914. This list includes all of the members admitted at the convention of 1913 not already included in the report of the Secretary for 1913, the new members admitted during the year, including the municipal members and their delegates, where they have been appointed. The delegates of municipal members who were already active members in the A. S. M. I. have been designated by a star and are really on two lists of members and should not be counted as additions:

ACTIVE.

John E. Ballinger, Engineer of Highways, Jacksonville, Florida.

Charles J. Bennett, State Highway Commissioner, Hartford, Conn.

L. D. Smoot, Chief Engineer, Jacksonville, Florida.

Joshua Atwood, Chief Engineer Paving Service, Pub. Wks. Dept., Boston, Mass.

Allen R. Boudinot, City Engineer, Davenport, Iowa.

William M. Brown, Chief Engineer Passaic Valley Commission, Newark, New Jersey.

Wallace L. Caldwell, District Manager, Pittsburgh Testing Laboratory, Birmingham, Alabama.

Frederick H. Clark, Supt. Streets and Engineering, Springfield, Mass.

Edgar S. Dorr, Chief Engineer Sewer Service, Boston, Mass.

Frank P. Drane, Paving Inspector and Supervisor, Charlotte, N. C

Harrison P. Eddy, Assistant Engineer, Pittsfield, Mass.

Arthur B. Farnham, Engineer Board of Works, Pittsfield, Mass.

Frederick Herston Frankland, Bridge Engineer, Highway Dept., Lake Charles, La.

E. L. Gorham, City Engineer, Lake Charles, La.

George B. Hills, Eng. Mgr. Isham Randolph & Co., Jacksonville, Fla.

Gilbert Hodges, acting as City Engineer, Franklin, N. H.

Prevost Hubbard, Consulting Chemical Engineer, Washington, D. C.

William H. Jaques, Mayor Village Dist. Little Boar's Head, Boston, Mass.

Alexander L. Kidd, Dist. Engr Public Works Dept., Boston, Mass.

B. H. Klyce, Design and Construction Sewers and Paving for Miami, Miami, Florida.

C. W. Koiner, Genl. Mgr. and Elec. Engr. Municipal Lighting Works, Pasadena, Cal.

R. J. Lewis, City Engineer, Fort Madison, Iowa.

David Russell Lyman, Chief Engineer, Bd. Public Works, Louisville, Ky

Franklin M. Miner, Assistant Engineer, Boston, Mass.

Edward W. Quinn, Superintendent of Streets, Cambridge, Mass.

Robert Isham Randolph, Secy.-Treas. Isham Randolph & Co., Chicago, Ill.

L. M. Russell, City Engineer, Elkhart, Indiana.

Edward E. Sands, City Engineer, Houston, Texas.

E. F. Scattergood, Elec. Engr. Dept. Public Service, Los Angeles, Cal.

William J. C. Semple, Assistant Engineer, Boston, Mass.

Charles W. Sherman, Consulting Member Bd. Water Commrs. Belmont, Boston, Mass.

J. J. Smith, City Engineer, East Grand Forks, Minn.

Frederic Antes Snyder, Chief Engineer Town of Mount Royal, Montreal, Que., Canada.

Elbert W. Sylvester, Chief Engineer and Supt. Public Works, Poughkeepsie, N. Y.

Thomas J. Wasser, County Engineer, Jersey City, N. J.

L. J. Wertheim, City Engineer in charge Public Works, Berlin, N. H.

Robert Spurr Weston, Consulting Sanitary Engineer, Boston, Mass.

AFFILIATED.

John Campbell, Supt. Special Service Dept. The Edison Electric Illuminating Company, Boston, Mass.

William Slifer, Consulting Civil Engineer, Pittsburgh, Pa.

Clyde H. Teesdale, in charge of Wood Preservation, Forest Products Laboratory, Madison, Wis.

MUNICIPAL.

Albany, N. Y.:
- *Wallace Greenalch, Commissioner of Public Works.
- *Frank R. Lanagan, City Engineer.
- Erwin B. Stevenson, Deputy City Engineer.
- James R. Watt, President of the Common Council.

Baltimore, Md.:
- Bruce Aldrich.
- R. Keith Compton.
- H. M. Cooksey.
- *H. K. McCay.

Boston, Mass.:
- Delegates for 1914 not yet appointed.

Buffalo, N. Y.:
- George H. Norton, Deputy Engineer, Commissioner, Dept. Public Works.
- C. E. P. Babcock, First Assistant Engineer, Dept. Public Works.
- J. A. Vandewater, Assistant Engineer, Dept. Public Works.
- Carl L. Howell, Assistant Engineer, Dept. Public Works.

Chicago, Ill.:
- Delegates for 1914 not yet appointed.

Columbus, Ohio:
- Delegates for 1914 not yet appointed.

Kalamazoo, Mich.:
- *A. Lenderink, City Engineer.
- M. E. McMartin, City Auditor.
- C. L. Miller, City Clerk.

Kansas City, Mo.:
Robert L. Gregory, President Board of Public Works.
Curtis Hill, City Engineer.
Clark R. Mandigo, Assistant City Engineer.
E. J. McDonnell, Secretary Board of Public Works.

Little Rock, Ark.:
*Henry Levinson.
Fred Lund.
D. A. MacCrea.

Lynchburg, Va.:
*L. D. Shaner, City Engineer.

Memphis, Tenn.:
George C. Love, Commissioner of Streets, Bridges and Sewers.
D. C. Miller, Chief Clerk, Engineering Department.
C. C Pashby, City Clerk.
*J. H. Weatherford, City Engineer.

Minneapolis, Minn.:
*F. W. Cappelen, City Engineer.
Ellis R. Dutton.
P. B. Walker.
George V. Ziemer.

New Haven, Conn.:
Max Adler, President Permanent Paving Committee.
W. Scott Eames, Director of Public Works.
Frederick L. Ford, City Engineer.
Cassius W. Kelly, Consulting Engineer.

New Orleans, La.:
W. J. Hardee, City Engineer.
Edward E. Lafaye, Commissioner of Public Property.
Harold W. Newman, Commissioner of Public Safety.
W. B. Thompson, Commissioner of Public Utilities.

New York, N. Y.:
*E. J. Fort, Chief Engineer Bureau of Sewers, Boro of Brooklyn.
*R. H. Gillespie, Chief Engineer of Sewers and Highways, Boro The Bronx.
*Nelson P. Lewis, Chief Engineer Board of Estimate & Apportionment.
*George W. Tillson, Consulting Engineer, Boro of Brooklyn.

Norfolk, Va.:
Delegates for 1914 not yet appointed.

Omaha, Neb.:

Joseph B. Hammel, Superintendent of Parks and Public Property.
A. C. Kugel, Superintendent Department of Police and Public Safety.
Thomas McGovern, Superintendent of Public Improvements.
Watson Townsend, City Engineer.

Pasco, Wash.:

Delegates for 1914 not yet appointed.

Philadelphia, Pa.:

William H. Connell, Chief of the Bureau of Highways.
Carleton E. Davis, Chief of the Bureau of Water.
William D. Uhler, Assistant Engineer Bureau of Highways.
George S. Webster, Chief of the Bureau of Surveys.

Pittsburgh, Pa.:

George W. Burke, Superintendent Bureau of Parks.
E. E. Lampher, Division Engineer, Bureau of Water.
*C. M. Reppert, Division Engineer, Bureau of Engineering.
J. D. Strain, Superintendent Municipal Asphalt Plant.

St. Louis, Mo.:

Walter L. Hempelmann, Engineer Bituminous Roadways, Street Dept.

Salisbury, N. C.:

Delegates for 1914 not yet appointed.

Salt Lake City, Utah:

Delegates for 1914 not yet appointed.

South Omaha, Neb.:

Delegates for 1914 not yet appointed.

Toledo, Ohio:

A. W. Boardman, Director of Public Service.
G. A. Gessner, Resident Bridge Engineer, Dept. of Public Service.
Herbert McKechnie, Chief Engineer of the Dept. of Public Service.
Thomas A. Taylor, Supt. of Streets of the Dept. of Public Service.

Binghamton, N. Y.:

Burr Winsor, Commissioner of Public Works.
*John A. Giles, City Engineer.

Fulton, N. Y.:

G. Clayton Hill, City Engineer.
F. H. Ramsey, Commissioner of Works.

Joplin, Mo.:

J. B. Hodgdon, Commissioner of Streets and Public Improvements.

Toronto, Ontario, Canada:
R. C. Harris, Commissioner of Works.

Troy, Ohio:
M. A. Gantz, City Engineer.

ASSOCIATE.

The American City, Harold S. Buttenheim, Editor, New York City.
The Barber Asphalt Paving Company, Philadelphia, Pa.
Clifford Richardson, New York City.
C. N. Forrest, Maurer, N. J.
The Equitable Asphalt Maintenance Company, Kansas City, Mo.
Ford H. Moore, Secretary-Treasurer.
James M. Moore.
General Petroleum Company, San Francisco, Cal.
F. J. Lewis Manufacturing Company, Chicago, Ill.
F. J. Lewis, President.
Standard Oil Company of New York, New York City.
Henry Fisher, Manager.
United Gas Improvement Company, Philadelphia, Pa.
W. H. Fulweiler, Chemist.
Universal Portland Cement Company, Chicago, Ill.
C. W. Boynton, Chicago.
J. H. Chubb, Chicago.
William M. McKinney, Pittsburgh, Pa.
Warner-Quinlan Asphalt Company, New York City.
W. D. Baker, Sales Manager.
H. J. Gillum, General Salesman Magnolia Petroleum Co., Chicago, Ill.
Arthur S. Lane, Treas. John S. Lane & Son, Inc., Meriden, Conn.
L. R. McKenzie, Sales Manager, California Brick Co., San Francisco, Cal.
H. H. Morgan, Manager Chicago Cement & Physical Testing Dept. of the Robert W. Hunt Co., Chicago, Ill.
Charles P. Price, Manager The American Tar Company, Boston, Mass.
The United States Asphalt Refining Company, New York City.
J. R. Draney, Sales Manager.
Sir Gust. Pers. Wern, President, Wern Machinery & Engineering Co., New York City.

The following members withdrew under the provision of the Constitution whereby a member has the option of continuing his membership after he leaves municipal employment:

James B. Estee, Mayor, Montpelier, Vt.
Robert J. Harding, Supt. of Public Works, Poughkeepsie, N. Y.
Samuel D. Newton, Greensboro, N. C.

The following associate members have also withdrawn:

Rudolph S. Blome Co.
Canadian Iron & Foundry Co.
William J. Cherry.
C. P. Dodge.
Foote Concrete Machinery Co.
International Creosoting & Construction Co.
Newton Jackson.
Municipal Journal.
B. V. Norton.
Henry Tipper.
H. L. Gillespie.
H. D. Wyllie.
R. C. Stubbs.

The following changes in classification of members have been made:

L. C. Datz, Engineer Roadway, N. O. Railway & Light Co., New Orleans, La., from Associate to Affiliated Member.

D. A. Hegarty, Manager, N. O. Railway & Light Co., New Orleans, La., from Active to Affiliated Member.

The following members have died:

Justus Herbert Grant, Special Assistant Engineer, Rochester, N. Y.
S. H. Phelps, City Engineer, Sharpsville, Pa.

The following were elected to membership at the convention and are not included in the account of membership given in the Secretary's report:

ACTIVE.

Frank A. Barbour, Boston, Mass.
Harland Bartholomew, Secy., Newark City Plan. Com., Newark, N. J.
Arthur W. Dean, Chief Eng. Mass. Highway Com., Winchester, Mass.
Michael Driscoll, Supt. Streets and Sewers, Brookline, Mass.
Charles P. Gillen, Board of Street and Water Com., Newark, N. J.
John M. Keyes, Chairman, Board of Road Com., Concord, Mass.
James H. MacDonald, Road and Pavement Expert, New Haven, Conn.
Roger L. Morrison, Prof. Highway Engineering, College Station, Texas.
Manley Osgood, City Engineer, Ann Arbor, Mich.
Herbert W. Pierce, Commissioner Public Works, Rochester, N. Y.
William D. Sohier, Chairman, Mass. Highway Com., Boston, Mass.
H. M. Talbott, City Engineer, Owensboro, Ky.

MUNICIPAL.

Binghamton, N. Y.:
  Burr Winsor, Commissioner of Public Works.
Joplin, Mo.:
  John B. Hodgdon, Commissioner of Streets and Public Improvements.

ASSOCIATE.

Arthur A. Adams, Contractor, Adams & Ruxbon Construction Co., Springfield, Mass.
W. T. Blackburn, Con. Eng., Dunn Wire-Cut-Lug Brick Co., Paris, Ill.
Albert C. Bruff, Dist. Mgr. Edison Portland Cement Co., Quincy, Mass.
Frederick M. Crossett, Prest. and Mgr. Wern Stone Paving Co., New York City.
Frank T. Fay, Sales Agt., Standard Oil Co. of New York, Boston, Mass.
H. V. Hildreth, General Manager, Hildreth Granite Co., Boston, Mass.
Dennis A. Kennedy, Boston Manager, John Baker, Jr., Boston, Mass.
William L. D'Olier, Chief Engr. The Sanitation Corporation, Philadelphia, Pa.
G. H. Perkins, Supt. of Refineries, Warren Brothers Co., Boston, Mass.
James J. Smith, Salesman Frank Ridlor Co., Boston, Mass.
George M. Stevens, Salesman, Boston, Mass.
O. G. Strother, Pa. Rep. U. S. Wood preserving Co., Harrisburg, Pa.
Robert W. Pond, Manager Boston Road Dept., Barrett Mfg. Co., Boston, Mass.

REPORT OF TREASURER.

W. B. HOWE.

To the American Society of Municipal Improvements:

Gentlemen: Your Treasurer presents the following report of the receipts and expenditures of the Society for the year ending October 6, 1914:

Receipts

Nov. 1, 1913—A. P. Folwell	$525.50
Nov. 1, 1913—E. L. Dalton, balance from 1913	1,113.80
Dec. 3, 1913—Charles C. Brown	133.75
Jan. 8, 1914—Charles C. Brown	56.25
Feb. 11, 1914—Charles C. Brown	1,047.18
Mch. 5, 1914—Charles C. Brown	128.25
April 13, 1914—Charles C. Brown	110.00
May 22, 1914—Charles C. Brown	76.75
June 22, 1914—Charles C. Brown	40.00
July 8, 1914—Charles C. Brown	260.00
Aug. 7, 1914—Charles C. Brown	87.75
Sept. 8, 1914—Charles C. Brown	575.75
Oct. 1, 1914—Charles C. Brown	332.75
	$4,487.73

Expenditures.

Dec,	1, 1914	—Central Law Reporting Co., report Wilmington convention	$75.00
Dec.	1, 1913	—A. Prescott Folwell, office expenses	64.87
Dec.	1, 1913	—Frank F. Lisiecki, programs for convention	18.00
Dec.	1, 1913	—The Franklin Press, letterheads, etc	20 00
Dec.	1, 1913	—Morrill & Danforth, premium, Treasurer's bond	7.50
Dec.	4, 1913	—Charles C. Brown, office expense	52.19
Dec.	5, 1913	—The Franklin Press, printing supplies	104.75
Jan.	9, 1914	—Charles C. Brown, office expense	57.68
Feb.	11, 1914	—Charles C. Brown, office expense	58.44
Feb.	11, 1914	—Union Oil Co., refund of dues A. S. P. S	10.00
Feb.	11, 1914	—Warren Brothers' Co., refund of dues A. S. P. S.	10.00
Feb.	11, 1914	—Yellow Pine Manufacturers' Association, refund of dues A. S. P. S	10.00
Feb.	11, 1914	—Standard Oil Co. of N. J., refund of dues	10.00
Feb.	11, 1914	—Anchor Printing Co., stationery	28.75
Mch.	5, 1914	—The Franklin Press, printing supplies	8.75
Mch.	5, 1914	—Rumford Printing Co., on account	150.00
Mch.	5, 1914	—Charles C. Brown, office expense	56.35
April	13, 1914	—Anchor Printing Co., stationery	62.90
April	13, 1914	—Indiana Electrotype Co., cuts for Proceedings	16.66
April	13, 1914	—Charles C. Brown, office expense	56.95
May	22, 1914	—Charles C. Brown, office expense	45.50
May	22, 1914	—Appollo T. Gaumer, drawings for Proceedings	1.40
June	20, 1914	—Anchor Printing Co., stationery	3.30
June	20, 1914	—Charles C. Brown, office expense	50.26
July	8, 1914	—G. Clayton Hill, refund of dues	2.50
July	8, 1914	—Charles C. Brown, office expense	55.00
Aug.	7, 1914	—The Franklin Press, envelopes	4.00
Aug.	7, 1914	—Charles C. Brown, office expense	55.02
Aug.	7, 1914	—Charles C. Brown, express on reprints	22.57
Aug.	14, 1914	—The Franklin Press, envelopes and printing	13.00
Sept.	8, 1914	—Anchor Printing Co., stationery	4.50
Sept.	8, 1914	—Charles C. Brown, office expense	117.36
Sept.	9, 1914	—Rumford Press, advance copies and report	984.35
Sept.	18, 1914	—A. E. Woodward, committee service	7.00
Sept.	21, 1914	—Printing Arts Co., plates for advance papers	11.08
Sept.	21, 1914	—Charles C. Brown, salary	300.00
Oct.	1, 1914	—Charles C. Brown, office expense	78.45
			$2,634.08

Receipts	$4,487.73
Expenditures	2,634.08
	$1,853.65

Respectfully submitted,

W. B. Howe,
Treasurer.

The President: We will have also report of Finance Committee.

FINANCE COMMITTEE REPORT.

To the President and Members of the American Society of Municipal Improvements:

Gentlemen: The Finance Committee beg to report that they have examined the financial accounts of the Secretary and Treasurer and find the accounts agree and balance in the amounts stated, as follows:

Balance from last report	$1,113.80
Received during the year	3,373.93
Total receipts	$4,487.73
Disbursements during the year	2,634.08
Balance	$1,853.65

Respectfully submitted,

L. V. CHRISTY,
F. J. CELLARIUS,
Finance Committee.

MR. MILLER: I move the three reports be received and adopted.

(Seconded by Mr. Howell, and carried.)

THE PRESIDENT: It is now time to adjourn, and we will take a recess at this time until two o'clock this afternoon.

AFTERNOON SESSION.

The session was called to order by President Christ at 2:30 P. M.

THE PRESIDENT: The first this afternoon is report of Committee on Garbage Disposal and Street Cleaning. Mr. Hoffman is not here, but his report is in the hands of the Secretary, and if there is no objection it will be printed in the Proceedings without reading.

The report will be found on page 1.

The first paper to be taken up, for we shall have to postpone the illustrated papers for an evening session, will be that

of Mr. S. A. Greeley of Winnetka, Illinois, on "Costs of Collecting, Hauling, Transferring and Transporting Refuse Materials." Mr. Greeley is not here, so I will ask the Secretary to read it.

The paper will be found on page 17.

THE PRESIDENT: If there is no discussion on this, we will pass to paper on "Street Cleaning," by Edward D. Very, Sanitary Engineer, New York City.

The paper and discussion thereon will be found on page 3.

THE PRESIDENT: If there is no further discussion of that paper, we will pass to the paper on "The High Temperature Incinerating Plant at Savannah, Georgia," by E. R. Conant, Chief Engineer of Savannah, Georgia.

The paper and discussion thereon will be found on page 24.

THE PRESIDENT: With reference to the report of Committee on Street Lighting, Mr. Putnam, the chairman, has been unavoidably detained. He will forward the report and his paper, to the Secretary, and they will be printed in the Proceedings.

The report will be found on page 438 and a paper by G. H. Stickney on "Street Lighting Practice With Incandescent Lamps," on page 439.

If there is no objection also, we will have the paper, "Municipal Ownership and Operation of Electric Utilities on the Pacific Coast," by Mr. C. Wellington Koiner, engineer and general manager of the municipal electric light and power plant at Pasadena, California, read by title and printed in the Proceedings. We are compelled to do this, because we are so rushed for time.

The paper will be found on page 347.

The next will be the report of Committee on Sewerage and Sanitation, Mr. A. J. Taylor, of Wilmington, Delaware, chairman.

MR. TAYLOR: Ours is just a formal report of our activities during the year, and an appreciation of the efforts of different ones who have helped us, and a list of the papers procured, etc. We shall be glad to hand it in later to the Secretary.

The report will be found on page 61.

MR. CHRISTY: I move we adjourn at this time until this evening at 8 o'clock.

(Seconded by Mr. Corson, and carried.)

EVENING SESSION.

The meeting was called to order by the President at 8 o'clock.

THE PRESIDENT: We will take up first this evening the paper on "Sewage Disposal, Preliminary Investigations Required," by E. A. Fisher, consulting engineer of Rochester, N. Y.

The paper and discussion thereon will be found on page 63.

THE PRESIDENT: We will now have paper on "Municipal Cleanliness," by I. S. Osborn, consulting engineer in charge of installing complete methods of refuse collection and disposal for Toronto, Canada.

The paper and discussion thereon will be found on page 49.

THE SECRETARY: By order of the Executive Committee, and in accordance with our rules, I will present to you at this time the following proposed amendment to the constitution: In the second paragraph of the first section of the second article, in the second line, add "by signifying his desire so to do," after "active membership."

THE PRESIDENT: Mr. George T. Hammond, engineer in charge, will now read us his paper on "The Experimental Sewage Disposal Plant of Brooklyn, N. Y."

(Mr. Hammond reads paper, and later shows slides illustrating same.)

The paper and discussion thereon will be found on page 121.

THE PRESIDENT: We will next have paper on "The Disposal of Inflammable Wastes Into Sewerage Systems and the Problem of Prevention," by Norman S. Sprague, Superintendent Bureau of Construction, Pittsburgh, Pa.

The paper and discussion thereon will be found on page 163.

THE PRESIDENT: We have one more paper for tonight, and that is the paper on "Permanent Sediment Records for Water and Sewage," by George C. Whipple, consulting engineer, New York City, Professor of Sanitary Engineering in Harvard University and the Massachusetts Institute of Technology.

The paper will be found on page 176.

MR. WHIPPLE: I am not going to read the paper, because it is too late, and I take it it will be printed in the Proceedings. But I do want to show you here a quick and simple device for analyzing water, by passing the samples of water through small cotton discs. The little device is called the Wizard Sediment Tester, and is made by the Creamery Package Company of Albany, N. Y., and is so simple that with it the office boy can make a fairly good and accurate test as to impurities in the water.

THE PRESIDENT: There is one other paper here, "The Milwaukee Sewerage Problem," by Mr. T. Chalkley Hatton, of Milwaukee, Wisconsin, but it is so late that if there are no objections, we will have it printed in the Proceedings without reading.

The paper will be found on page 96.

That ends the evening's program, and if there is nothing further, we will stand adjourned until tomorrow morning at nine o'clock.

WEDNESDAY, OCTOBER 7, 1914.

MORNING SESSION.

The meeting was called to order at nine o'clock by Vice-President Howell.

MR. HOWELL: The first thing on the program for this morning is the report of Committee on Fire Prevention, by Mr. Alcide Chausse, chairman.

The report will be found on page 193.

MR. HOWELL: If there is no discussion of the report, we will take up next paper on "Fire Prevention," by Mr. J. C. McCabe, Boiler Inspector, of Detroit, Mich. I will ask the Secretary to read the paper.

The paper will be found on page 202.

THE SECRETARY: Attached to the paper is the suggested ordinance, which has been scientifically prepared, and which is offered as the standard for such ordinances in this country.

THE PRESIDENT: We will next have an address by Mr. Franklin H. Wentworth, Secretary of the National Fire Protection Association, Boston, Mass.

The address will be found on page 205.

MR. CHAUSSE: I move that a vote of thanks be tendered Mr. Wentworth for this very fine address.

(Seconded by Mr. Corson, and carried.)

MR. HOWELL: We will now take up a paper that was left over from last night, on "Economics of Sewage Filters," by George W. Fuller, Consulting Engineer, New York City. Mr. Fuller is not here, and I will read it.

The paper will be found on page 113.

MR. HOWELL: If there is no discussion of that, we will take up the report of Mr. Tribus of the Committee on Traffic on Streets.

The report will be found on page 184.

MR. HOWELL: The next will be paper by Mr. Clarence D. Pollock, Consulting Engineer, New York City, on "Small Parks for Southern Cities."

The paper and discussion thereon will be found on page 228.

MR. HOWELL: If there is no further discussion of Mr. Pollock's paper, we will take up the paper of Mr. Tribus on "The City Efficient." I will ask the Secretary to read it.

The paper will be found on page 377.

THE SECRETARY: I have here some communications which perhaps should be read at this time.

Some persons attending the convention have inquired about the practicability of inspecting the sewage treatment plant at Fitchburg, Mass. This plant consists of five Imhoff tanks; two dosing tanks; two acres of trickling filters, and four secondary sedimentation tanks. The plant is practically finished and will be put into operation this week. If several desire to go to Fitchburg, arrangements can be made for them to go together on Friday afternoon, leaving Boston, North Station, at 1 P. M., and reaching Fitchburg at 2:23; leaving Fitchburg at 5:28 and returning to Boston at 6:55. If there are those who desire to take this trip, they will be met at the station in Fitchburg and escorted to the plant. The trains suggested have been selected as it is understood that several excursions may be planned for Friday afternoon.

If I can be of assistance to you in making further or different arrangements, I am at your service.

Cordially yours,

HARRISON P. EDDY.

The American Road Builders' Association will hold its Eleventh Annual Convention on December 14-18, 1914, inclusive, in the International Amphitheatre, Chicago, Ill.

The object of this Association, as its name indicates, is to promote the construction of good roads, and this is one of the objects of your Society.

The officers of the American Road Builders' Association extend to all the members of the American Society of Municipal Improvements a cordial invitation to be present at its convention. The Association feels

that all of your members that attend the convention will receive material benefit by so doing.

The Association trusts that many members of your Society will accept this invitation.

Respectfully,

GEO. W. TILLSON,
First Vice-President.

I received a letter the other day from Mr. Calvin W. Rice, Secretary, American Society of Mechanical Engineers, in which he asked if I would be good enough to speak with you about having an invitation extended to our Society of Municipal Improvements to attend the annual meeting of the Mechanical Engineers in New York City, in December, when municipal engineering problems will be a special subject of discussion. I hope that this may be arranged as the program looks to me to be an interesting one.

Very truly yours,

GEORGE W. FULLER.

MR. HOWELL: We will have the report of the Obituary Committee.

REPORT OF OBITUARY COMMITTEE.

The Obituary Committee regrets to have to report the death of two members of this Association during the past year:

J. Herbert Grant, died at Rochester, N. Y., August 1, 1914.

Mr. Grant was long identified with various movements in the City of Rochester, having for the object the betterment of the city. From 1904 up to the time of his death he had charge of street pavements, sewers and other public improvements in that city.

S. H. Phelps, died July 3, 1914.

Mr. Phelps was city engineer of Sharpsville, Pa. He held many important municipal positions during his life and at the time of his death was Treasurer of the city as well as its Chief Engineer.

Respectfully submitted,

CLARK G. ANDERSON, *Chairman.*
H. H. SCHMIDT.
J. W. FLENNICKER.

MR. HOWELL: If there is nothing further at this time, I will declare the meeting adjourned until this evening at eight o'clock.

EVENING SESSION.

This session was called to order by the President, at 8:15 P. M.

THE PRESIDENT: We will take up first the matter of the election of officers, and will have the report of the Nominating Committee, Mr. Giddings, chairman.

REPORT OF THE NOMINATING COMMITTEE.

To the American Society of Municipal Improvements.

Gentlemen: Your Nominating Committee begs leave to submit the following names for the several offices indicated for your consideration:

President—William A. Howell, Newark, N. J.

First Vice-President—A. F. Macallum, Hamilton, Ont.

Second Vice-President—N. S. Sprague, Pittsburgh, Pa.

Third Vice-President—E. L. Dalton, Dallas, Texas.

Secretary—Charles Carroll Brown, Indianapolis, Ind.

Treasurer—W. B. Howe, Concord, N. H.

Finance Committee—F. J. Cellarius, Dayton, O.; L. W. Christy, Wilmington, Del.; R. Keith Compton, Baltimore, Md.

FREDERICK GIDDINGS.
E. A. FISHER.
A. PRESCOTT FOLWELL.
CHARLES P. GILLEN.
HERMAN H. SCHMIDT.

MR. MILLER: I move the report of the committee be accepted by the association, and that the Secretary be instructed to cast the ballot of the Society for the officers named in the report.

Seconded by Mr. Reimer, and carried, and ballot so cast.

THE PRESIDENT: The next thing to come before us is the selection of next place of meeting.

THE SECRETARY: We have invitations from St. Louis, Atlantic City and Buffalo, cities where we have already met. Buffalo was where the Society was organized, and we might consider that was not a convention. We have invitations also from Columbus, Ohio; Dayton, Ohio; Denver, New Orleans, New York City, Oakland, California; San Francisco, Springfield, Massachusetts, and Toledo, Ohio.

(The Secretary read some of the many communications.)

Mr. Allen extended an invitation from New Orleans, which was seconded by Mr. Hardee; Mr. Norton extended an invitation from Buffalo; and Mr. Cellarius presented the invitation from Dayton, Ohio, which was seconded by Mr. Sprague and Mr. Hallock. The ballot resulted in a majority for Dayton, and on motion of Mr. Allen, the vote in favor of Dayton was made unanimous.

MR. ALLEN: I wish to notify the convention, on behalf of New Orleans, that we are going to invite the convention again next year, unless Newark enters the field. If Newark is in the field, we shall be for Newark; otherwise we shall renew our invitation to come to New Orleans. (Applause.)

THE PRESIDENT: Capt. Hardee has presented the following resolution:

Whereas, The Association for Standardizing Paving Specifications, now merged with the American Society of Municipal Improvements, has devoted four consecutive meetings exclusively to the consideration and formulation of paving specifications, which after most careful consideration of facts and figures presented by all interested parties at numerous extended sessions of its various committees reached conclusions which have been widely circulated and come to be regarded as standard; and

Whereas, The American Society of Municipal Improvements has formulated, printed and circulated, paving specifications differing slightly but not materially therefrom; and

Whereas, Specifications once adopted should have more than one year trial to demonstrate their merit, and any changes that may be deemed necessary in the paving specifications approved and adopted by the former Association and this Society growing out of individual experiences should be a matter of most careful consideration by all the members of this body; and

Whereas, None of the paving specification committees have this year made reports in time to submit copy of the same through the Secretary for printing and consideration as well as review, and additionally have not had time to meet and hear discussions;

Therefore, be it Resolved: That the specifications for various types of street and highway pavements adopted by the Association for Standardizing Paving Specifications at its 1913 Pittsburgh meeting and the specifications adopted by this Society at its 1913 Wilmington meeting in so far as each will meet local conditions in various cities, be and the same are hereby adopted by this Society for the year 1915.

Be it Further Resolved: That as soon as practicable after our adjournment the Secretary send to all members of this Society a copy of the specifications referred to in the preceding paragraph, both of which are available for this purpose, with the request that all criticisms and suggestions be forwarded to him within four months, the same to be printed under the direction of the Secretary and forwarded to all the members of this Society so that they may be advised of proposed changes and may be carefully considered by action at our next annual meeting.

MR. HARDEE: I move the adoption of the resolution.

MR. GIDDINGS: I will second it.

MR. SHERRERD: There are a number of specifications on pavements presented to this meeting concerning which there

seems to be unanimity of sentiment for their adoption, and I think it would be unwise to pass this resolution at this time. I will move, on behalf of the General Committee, that the consideration of this resolution go over until the report of the Committee on Specifications is received.

MR. SMITH: As member of one of the sub-committees, I wish to say that I hope you will not adopt this resolution. It entirely wipes out the hard work the General Committee and the various sub-committees have done, and I believe their reports should be heard. I will second Mr. Sherrerd's motion.

MR. HOWARD: It would seem that we might adopt this resolution, and yet go ahead and take the reports of the committees when they are presented.

MR. HALLOCK: The adoption of this resolution would scarcely be fair to the committees. They have worked hard on these things, and are entitled to have their report received.

MR. REIMER: I believe Mr. Sherrerd's motion should prevail.

MR. FISHER: I believe this resolution to be discourteous to the committee. As a simple matter of courtesy, the committee should be given opportunity to make its report.

MR. FOLWELL: I believe the action contemplated by this resolution would be extremely discourteous to the committee. We have always given the reports of committees very careful consideration, and not fifty per cent. of our committee reports have been accepted; so there need be no fear but that these specifications will have full consideration and discussion.

MR. HARDEE: I presented the resolution looking only to the best interests of the Society, and I certainly want to disclaim any intention to do a single discourteous act. If that is the desire of the Society, I shall be very glad to accept Mr. Sherrerd's amendment.

Motion of Mr. Sherrerd carried.

The President: We will continue with our program, the first thing this evening being paper by Mr. Alexander Potter, Consulting Engineer, New York City, on "Converting an Old Septic Tank Into a Modern Two-Story Tank."

The paper and discussion thereon will be found on page 79.

(*Vice-President Howell takes chair.*)

The President: If there is nothing further on this, we will have a demonstration by Mont. Schuyler, of the Municipal Testing Laboratory at St. Louis, Missouri, of a machine for testing clay materials.

Mr. Schuyler: You see the machine set up here before you. It consists of a vertical motor, with a turned steel hub on the upper end of the shaft. In the central cavity there are two radial arms. The motor throws the arms around much as the blades of a centrifugal fan. Around the periphery are placed the objects you expect to test, and the sand coming from the tube with a velocity of 400 or 500 feet per second, wears the brick or whatever material you put in, an action which is probably one of impact, although there may be a slight abrasive action, due to the fact that the grains impinge on the brick at an angle of about 30 degrees.

The property desirable in paving brick is undoubtedly toughness. Extreme hardness, with concurrent brittleness, is not desirable, nor is softness, because of the wear the brick receive in the street.

Mathematical investigation of the action of the sand blast shows that the forces there are those of impact. If the sand were projected radially, the action would be entirely impact.

With this machine twelve brick can be tested at one time. You can of course test different portions of the brick, the wearing surfaces or sides if you care to. The machine is almost noiseless, and can be made dustless. The brick can be readily identified after testing, and will serve as a guide to the inspector on the street. The machine costs about $90, I think.

I don't want to get into discussion as to whether this is a substitute for the rattler test, but I believe it is a machine worth studying, and I propose it to you from that angle. It is possible with this machine to select samples from streets that have seen service, and get their co-efficient of wear very easily, and complete the test, not taking over three minutes. I don't think that is possible in all cases with the rattler. (Applause.)

(*The President resumes chair.*)

THE PRESIDENT: The next will be paper on "Concrete Highways," by George W. Myers, Road Engineer, Association of American Portland Cement Manufacturers, Columbus, Ohio.

The paper will be found on page 248.

THE PRESIDENT: With your permission, we will postpone the discussion of this paper until tomorrow night, when there will be another paper on this same subject. The next is report of Committee on Park Development and Maintenance, George A. Parker, chairman, Superintendent of Parks, Hartford, Conn.

The report and discussion thereon will be found on page 216.

THE PRESIDENT: We have next a note on "Cleaning and Maintenance of Pavements Without Sprinkling," by Walter F. Slade, Commissioner of Public Works, Providence, R. I. I will ask the Secretary to read it.

The paper and discussion thereon will be found on page 11.

THE PRESIDENT: That closes the program for the evening, and I will declare the meeting adjourned until nine o'clock tomorrow morning.

THURSDAY, OCTOBER 8, 1914.

MORNING SESSION.

Meeting called to order by the President at 9:30 A. M.

THE PRESIDENT: We will have first the report of the Executive Committee.

THE SECRETARY: The Executive Committee has elected 27 members since the opening of the convention, most of whom are from the New England states and due to the activities of the Local Committee.

The list will be found in the Secretary's report on page 714.

The former Secretary and Treasurer for the A. S. P. S. makes the following report, which is approved by the Board of Directors, and presented to the Association:

To the Officers and Members of The American Society of Municipal Improvements:

Gentlemen: I have the honor to present the final report of the monetary affairs of the Association for Standardizing Paving Specifications.

At the Pittsburgh meeting of the Association, an assessment of $15 was levied on cities of second class membership; and an assessment of $25 on cities of the first class, and on the Associate Members which had paid dues of $200. Also the dues for Associate Members was changed to $50 and such an initial fee was paid by the following nine companies:

F. J. Lewis Manufacturing Co.
General Petroleum Co.
Standard Oil Co. of New Jersey.
Standard Oil Co. of New York.
The Dunn-Wire-Cut Lug Brick Co.
Equitable Asphalt Maintenance Co.
The United Gas Improvement Co.
Warner-Quinlan Asphalt Co.
Yellow Pine Manufacturing Association.

Albany, New York, became a member in April, 1913; Portland, Oregon, paid its assessment and resigned its membership on August 1st, 1913.

The assessments were paid by:

Cities of the First Class—Baltimore, Boston, Buffalo, Chicago, Columbus, Kansas City, Memphis, Minneapolis, New Haven, New Orleans, New York, Omaha, Philadelphia, Pittsburgh, Portland, St. Louis, Toledo.

Cities of the Second Class—Kalamazoo, Little Rock, Lynchburg, Norfolk, Pasco, Salisbury, Salt Lake City, South Omaha.

Associate Members—American Association of Creosoted Wood Paving Manufacturers, Barrett Manufacturing Co., National Paving Brick Manufacturers' Association, Standard Asphalt and Rubber Company, The Barber Asphalt Paving Company, The Texas Company, Union Oil Company of California, Universal Portland Cement Company, Warren Brothers Company.

Under date of December 27th, 1913, President Sprague wrote me as follows:

"My Dear Mr. Hittell:

In pursuance of action taken by the Executive Committee of the A. S. P. S., relative to the disposition of funds remaining in the treasury, you are hereby directed to dispose of these funds in the following manner:

Return to the City of Albany $30; to the Associate Members, who have joined since the Pittsburgh meeting, $25 each; and the balance transmit to the Secretary of the American Society of Municipal Improvements, with instructions to credit the following with annual dues:

Each city of the first class $20.

Each city of the second class $15.

Each Associate Member $10."

And a check for six hundred forty-eight and 68/100 ($648.68) was sent to Mr. Brown, January 14th, 1914.

STATEMENT.

Balance on hand as per statement rendered Feb. 22, 1913			$605.26
Receipts			
Dues, one city at $50		$50.00	
Dues, nine Associate Members at $50		450.00	
Assessments, seventeen cities at $25		425.00	
Assessments, nine Associate Members at $25		225.00	
Assessments, eight cities at $15		120.00	
Sale of Proceedings		378.75	
Interest		4.48	
			1,653.23
			$2,258.49
Disbursements.			
Expense, Fourth Annual Meeting		$210.15	
Expenditures of committees—			
Asphalt	$6.00		
Brick	15.00		
Wood Block	4.50		
President Hardee	57.85		
		83.35	
Printing Proceedings		548.80	
Postage		20.00	
Expressage		38.97	
Supplies, stationery, etc.		45.39	
Messenger and exchange		8.15	
Stenographers' work (Miss Carr, Miss Chandler)		100.00	
Assistant to Secretary-Treasurer, March 1st to Dec. 31, 1913		300.00	
Check to C. C. Brown, Secretary A. S. M. I.		648.68	
Dues remitted:			
Albany	$30.00		
Associate Members (9)	225.00		
		255.00	
			$2,258.49

An auditing committee, appointed by President Sprague, consisting of Messrs. L. A. Dumond, Linn White and Walter G. Leininger, has passed upon the financial report in detail.

Very truly,

JOHN B. HITTELL,

Secretary-Treasurer.

The board recommends the amendment to the constitution that was presented on Tuesday, that to Article II, Section 1, in the second paragraph there be added the words "by signifying his desire so to do" after "active membership."

MR. REIMER: I move the recommendation of the Executive Committee as to the amendment to the constitution be adopted by the association.

Seconded by Mr. Howell, and carried.

THE PRESIDENT: The next will be the report of the Committee on Standard Forms, Mr. Hallock, chairman.

The reports of the committee and its sub-committees and the discussion thereon will be found on page 482.

MR. HALLOCK: You will notice that most of the reports are simply progress reports. The sub-committees are handicapped by lack of data and information regarding practices now in vogue in the different cities. It will be necessary, to enable the sub-committees to prepare final reports, that considerable correspondence be carried on and considerable data collected. The committee would urge that the Secretary be authorized not only to give wide publicity to the progress already made by this committee, but to compile such data as will enable the different sub-committees to make more complete reports next year. The Secretary tells me that no replies were received to the printed circulars sent out last year in connection with this committee's work. That is discouraging, and we urge you to do your part in the coming year. We want to suggest a form that has come to our attention during the convention. It is a form for specifications, loose-leaf, each individual specification on a single leaf, and the engineer or inspector can carry it in his pocket, instead of having the bulky legal cap copy, which often contains much matter of no interest to the inspector. This also allows of changes in clauses without reprinting the whole specification. Specifications can easily be kept up to date with this. One page here

can be taken out and another one substituted. We recommend the adoption of this form for specifications.

THE PRESIDENT: We should do our best to answer these letters when sent out, so that we may soon get definite results.

MR. LENDERINK: I filled in Mr. Fetherston's report and mailed it, and it came back with the statement that he was not to be found at that address. I then hunted his address up, and sent it again.

THE PRESIDENT: When anything like that happens, it might be well to communicate with the Secretary.

MR. HALLOCK: The Sub-Committee on Street Lighting makes a verbal report, as follows: At the last convention their report was adopted, with the direction that they make further recommendation as to gas lighting. The chairman has not as yet been able to put the matter of gas lighting in form for recommendation to the Society.

The Sub-Committee on Sewer Construction and Maintenance presents for adoption two forms. They present a third form for consideration, but do not ask you to adopt it now.

The report and discussion thereon will be found on page 490.

The report of the Sub-committee on Bidding Blanks, which with discussion will be found on page 488, was then taken up.

MR. HALLOCK: With the change suggested of putting the width in this concrete curb and gutter specification, I move the adoption of the report as printed.

MR. FOLWELL: I will second it. Some may think these forms are too elaborate for a small town, but the idea is that every man should take this blank and see that it covers everything that he may run across. One member stated that on a large piece of work, $400,000, he didn't have a single dollar of extras. You know the extras are fought shy of by the commissioners. The reason he had no extras was because his bidding blank met every contingency, and he met everything that came up. This blank here is to cover every contingency, and

then you may be sure you haven't omitted anything that will come up afterward and bother you.

Motion carried.

The report of the Sub-committee on Standard Forms for Sewer Construction and Maintenance will be found with discussions on page 490.

MR. HALLOCK: I move the adoption of the form for sewer construction as printed.

Seconded by Mr. Tillson, and carried.

THE PRESIDENT: The Sub-Committee on Street Paving made no report, and that closes the work of this committee.

We will next take up the report of the Committee on Standard Specifications, Mr. Tillson, Chairman.

MR. TILLSON: I think the whole Society recognizes the importance of this subject. This has been handled for some years by a society whose only business was to take care of specifications only. It involves an enormous amount of work to work these specifications out. If we discussed them in detail in the convention, we would never get through. I want therefore to impress upon the members the necessity, when question arises in their minds with reference to these specifications, of taking the matter up with the committee during the year. The Sewer Committee's report was held over that such objections or questions might be taken up, but no communications have been received by that committee, although there were objections to the report as printed. The committees must have some help during the year, and not at these meetings only, so that they may formally state the objections, and have them ready for discussion at meetings of the committee during the year.

The reports of the committee and of its sub-committees with discussions thereon will be found on page 507.

The report of the sub-committee on Stone Block Paving was read as given on page 509.

MR. TILLSON: I move these specifications as presented by this sub-committee be adopted.

MR. REIMER: I will second that.

Motion carried.

MR. TILLSON: The President was the chairman of the next Sub-Committee on Brick Pavements and I will ask him to state the changes.

The report was made as given on page 521.

MR. TILLSON: I move the specifications as to brick pavements be adopted.

Seconded by Mr. Macallum, and carried.

The report of Sub-Committee on Concrete Paving Specifications was read, as given on page 541.

MR. TILLSON: I move these specifications be adopted as presented.

Motion carried.

The report of the Sub-Committee on Broken Stone and Gravel Roads was read as given on page 550.

MR. TILLSON: The idea is that the committee would later take the other things up. With my knowledge of the committee who prepared these specifications, I have no hesitancy in moving that these be adopted. I would like to have the Secretary publish a footnote in the Proceedings at the head of every specification he has printed and sends out, that any one, whether he is a member of this Society or not, is requested to send to the committee, through the Secretary, any objections or suggestions they may have for the committee's consideration.

Motion seconded by Mr. Lenderink, and carried.

MR. TILLSON: The next is the specifications for Asphalt Pavement. I will ask Mr. Smith, the chairman of the subcommittee, to handle this, and present it so that the association may know what the changes are.

The report was read as given on page 578.

MR. TILLSON: I move the specifications as presented be adopted.

Seconded by Mr. Macallum, and carried.

The report of the Sub-Committee on Sewers was read as given on page 608.

MR. TILLSON: Mr. Provost is the other member not signing the report, and I have a letter from Mr. Hering saying that Mr. Provost was out of town and his signature could not be obtained, but that he undoubtedly would sign this report. In the report of the General Committee it was suggested that these specifications be adopted, except as to two sections, 205 and 210 as printed, for which Mr. Parmley was going to substitute other sections, because he was not quite satisfied with these. The idea is to have these specifications printed as they are, and have the substitute sections suggested by Mr. Parmley also printed, neither adopted, but both to have action at the next convention. With this understanding, I move that these specifications be adopted.

Seconded by Mr. Fisher, and carried.

The report of the Sub-Committee on Wood Block was read as given on page 680.

MR. TILLSON: The General Committee recommend that this be printed and laid over for final action at the next meeting, and I would move that the recommendation of the General Committee with reference to these specifications be accepted.

Seconded by Mr. Macallum, and carried.

THE PRESIDENT: This concludes the work of the committee at this time.

THE SECRETARY: I believe a committee on resolutions should be appointed at this time.

THE PRESIDENT: If there is no objection, I will appoint on such committee Messrs. Macallum, Hallock and Giddings.

If there is nothing further to come before us at this time, we will now adjourn until eight o'clock this evening.

EVENING SESSION.

Session called to order by President Christ at 8:15 P. M.

THE PRESIDENT: We will take up first this evening the work of the Query Session.

THE SECRETARY: These are the results of inquiries sent out by the Clearing House of Information, and at least one member from each city has received the results.

The tabulations were read and described and will be found on page 467.

THE SECRETARY: I have here a telegram from Mr. A. E. Fletcher, President of the American Road Congress, extending to the members of this Society a cordial invitation to attend the Congress.

THE PRESIDENT: We will now discuss the standard forms for the gathering of data on sewers.

The report of the sub-committee and discussion thereon will be found on page 490.

MR. RANKIN: I move that the first two forms be adopted, and that the third be further considered.

Seconded by Mr. Potter, and carried.

MR. RANKIN: I move that in adopting Form 1, a footnote be added that the depth of the sewer be given to the extreme depth of the excavation.

MR. POTTER: Wouldn't it be better to make it the invert of the sewer, because there would be a varying depth depending upon the character of the foundation.

MR. RANKIN: Personally I would prefer that, but I thought from the discussion the majority of the members would prefer the other. I will change my motion to make it the invert of the sewer.

Motion seconded by Mr. Folwell, and carried.

THE PRESIDENT: We will take up now paper on "The Bleeding and Swelling of Longleaf Pine Paving Blocks,"

by C. H. Teesdale, in charge of Wood Preservation, Forest Products Laboratory, Madison, Wisconsin.

The paper and discussion thereon will be found on page 267.

THE PRESIDENT: We will have now the paper of Mr. Will P. Blair on "Vitrified Brick Street Construction."

The paper and discussion thereon will be found on page 289.

THE PRESIDENT: If there is nothing further on that, we will receive further report of the Committee on Specifications.

MR. TILLSON: The Sub-Committee on Bituminous Pavements is not ready with its report, and I would ask Mr. Linn White, chairman of the sub-committee, to make a statement with reference to their work.

MR. WHITE: The sub-committee has spent a great deal of time on these specifications, and we have made some progress. This situation has arisen, not particularly a new situation: The specifications heretofore printed as standard specifications and adopted by the Association amalgamated with our Society, presented two specifications for bituminous concrete, known as X and Y, and in the introduction to the specifications the attention of the engineers was called to the fact that any one using those specifications should remember and know that one pavement under them is a well known patented pavement and cities and municipalities using those specifications were advised to adopt their own policy as to the recognition of those patents. That means that is a specification which has been submitted that the committee and the Society did not state was a non-infringing specification. We have endeavored to go deeper and produce a specification which would be non-infringing, and which would, at the same time, be, in the belief of the committee, a good specification and one that would lay a good pavement. The committee had in view to offer two specifications to the Society, one of which would be a specification that we can state is a non-infringing specification, and that will be admitted by the bitulithic company, the holders of these patents, to be a non-infringing specification, and at the same

time offer another specification, which would be the bitulithic specification, thus making the matter perfectly clear to the prospective users of these specifications. We believe with a little further time we can submit such specifications as that, but did not feel we should go ahead without making some report to the Society. The specification that follows the lines of the bitulithic would be plainly stated, the word "bitulithic" would probably be used, would perhaps have to be used in that connection. This is a question of policy that had best be determined by the Society. I will move that the sub-committee be instructed to draft two such specifications, and submit them to the general committee for their consideration, and if approved by the general committee, that they then be printed in the annual Proceedings of this Society, as a tentative specification, not to be adopted until all members have an opportunity of examining and discussing them, and to be passed upon at the next convention, and that the sub-committee be allowed three months' time in which to prepare these specifications.

Seconded by Mr. Howard, and carried.

MR. HOWARD: I move that the specification on bituminous pavements of the A. S. P. S. be the one we endorse until this is accomplished, as that represents the latest and best there is along this line.

MR. MACALLUM: I fear that would be misleading. The specifications of that Association do not cover the exact ground they want to cover, and I will move to amend that we have no specifications on this until the report of the sub-committee is in.

MR. HOWARD: I will accept that, and second the amendment.

Motion carried.

THE PRESIDENT: The next is action on the resolution submitted by Capt. Hardee, which was laid over until after the general committee's report.

Mr. Tillson: I move the resolution be tabled indefinitely.

Seconded by Mr. Harris, and carried.

The President: We will take up next the paper of Mr. Warren on "The Effect of Leaking Illuminating Gas on Bituminous Pavements."

The paper and discussion thereon will be found on page 304.

Mr. S. R. Church: I have here a short discussion of Mr. Warren's paper which I should be glad to have printed in the Proceedings without reading.

This discussion will be found on page 318.

Mr. Tillson: With reference to the specifications adopted at this convention, we feel they are important, and if they are to be of benefit to the cities, they should be gotten out as early as possible. I will therefore move that the Secretary be authorized to print as early as possible all of the specifications adopted by the Society in pamphlet form, that one copy be issued to each member, and that they be sold at the rate of two dollars per copy. I would recommend that a thousand copies be printed.

Seconded by Mr. Howard, and carried.

Mr. Tillson: I would suggest when they are printed that it be stated exactly what action was taken on them at this convention.

The President: The next paper is that of Mr. Howell, on "Napped, Reclipped Grouted Granite Block Pavements, the Ideal Economical Pavement for Heavy Traffic Streets."

The paper and discussion thereon will be found on page 321.

Mr. Howell: Before starting I want to say that I thank you very much for the honor you have conferred upon me today by electing me President of the Society for the coming year. I appreciate it very deeply.

The President: We have another paper on this same subject, by Mr. S. C. Thompson, Engineer of Highways, Bronx Boro, New York.

MR. THOMPSON: My paper is quite similar to Mr. Howell's, and I would suggest it be printed in the Proceedings without reading. I did not know Mr. Howell's paper covered the details of the Bronx work, and my paper would contain a good deal of repetition.

The paper will be found on page 336.

THE PRESIDENT: The next is a paper on "Concrete Pavements," by Mr. H. G. Lykken, City Engineer, Grand Forks, N. D.

The paper will be found on page 257.

MR. HOWARD: I move Mr. Lykken's paper be read by title and printed in the Proceedings.

Seconded by Mr. Snyder, and carried.

THE PRESIDENT: We postponed until this session the discussion on concrete pavement, and if any one wishes to discuss it at this time, we shall be glad to hear from them.

If there is no discussion, this completes our work for this evening, and we will adjourn until nine o'clock tomorrow morning.

FRIDAY, OCTOBER 9, 1914.

MORNING SESSION.

The President called the meeting to order at nine o'clock A. M.

THE PRESIDENT: The first thing this morning is the report of the Committee on Municipal Legislation and Finance, Mr. Nelson P. Lewis, chairman. Mr. Lewis has been called away. He has left his report, and I will ask the Secretary to read it.

The report will be found on page 343.

THE PRESIDENT: There is also a paper by Mr. Lewis on "Recent Tendencies in City Charters."

The paper will be found on page 368.

THE PRESIDENT: The next is the paper on "Hints Leading to Good Budget Making for Municipalities," by William Thum, Pasadena, California.

The paper will be found on page 383.

MR. RANKIN: I move it be read by title.

Seconded by Mr. Matthew Brown, and carried.

THE PRESIDENT: We will now have the report of the Committee on Water Works and Water Supply, Mr. George W. Fuller, chairman, Consulting Engineer, New York City.

The papers presented by this committee and discussion thereon will be found on pages 427 and 435.

MR. FULLER: The Committee on Water Works and Water Supply has no report to make at this meeting. Last spring we endeavored to select some topic on this general line of work which would be a good one for discussion. We hit upon the topic of "Limitations of Water Filters." That is a great deal broader problem than would appear at first sight.

There were two reasons for its selection, one because of its relation to municipal problems where it is found cities are con-

sidering the question of whether an existing supply shall be filtered, or whether, with ordinary filtration works, some supplemental form of treatment shall be given, as is found in some places in Europe, where there is considerable pollution to a water supply. The other aspect of that question was suggested by the attention to an unusual degree that was at that time, and for some time previous, and for some time in the future will be, given to the international boundary waters between this country and Canada.

Some five years ago a treaty was entered into between this country and Great Britain whereby it was stipulated there should be an international joint commission appointed to deal with the pollution of inter-boundary waters. The purpose of that was to bring about the result that no injury to life or property should result on one side of the boundary from the sewage entering those boundary waters from the other side. That question has been investigated, as you know, by a special joint commission for a couple of years or so. A report dealing with the results of many thousands of analyses was completed last winter, and has recently been made public. The question then came before this International Joint Commission of finding out what was a reasonable yardstick in point of regulation of pollution in water supplies for them to adopt in treating the problems scattered along the length of these inter-boundary waters, starting up in the far West and the western feeders of Lake Superior, extending down through the Great Lakes district, and dealing with the waters of the St. Johns river in Maine and New Brunswick.

There was called in New York in May a meeting of the International Joint Commission, and there were asked six men to appear and give their views on this question, three Canadians and three Americans. I was one of the three American engineers asked to state views as to what would be a reasonable amount of pollution, beyond which those boundary waters should not be allowed to go. As is usually the case before a commission of that sort, which wants to deal with definite

propositions, we were all pushed on the witness stand strongly to state things specifically. The proposition of numbers of bacteria is rather a capricious thing to use as a yardstick. That, of course, had a good deal of standing in Germany twenty-five years ago, and is now used there with considerable satisfaction. That is dealing with waters relatively low in bacterial content, and not dealing at all with the wide ranges in number of bacteria and ranges in quality of bacterial flora as found in this country. The efficiency of filters and percentages of removal are all things that have their limitations, while helpful to a considerable extent under some circumstances. In the question of pollution of fecal matter, the so-called B. coli test seemed to be the one that would be most useful.

The upshot of this hearing at New York last May was that they provisionally set forth a standard, roughly stated as follows: That a water suitable for filtration, where the overload would not be serious, would be one which as an annual average would not contain more than 500 B. coli in 100 ccms. That is the style adopted in this International Joint Commission report. The water works men know it better when stated that as an annual average a sample of raw water going to a filter should not contain B. coli, by the so-called presumptive method, more than one-half of the time when testing one-tenth ccm.

This topic was proposed by this committee for discussion. There was a feeling on the part of several that it would be wise for this Society, dealing with the administrative policies of American cities, to look at such a proposition with considerable care. It does not necessarily follow that problems solved by a certain formula for the Great Lakes district and waters on the Canadian boundary are applicable throughout the nation. I found quite soon in correspondence and in conference with my associates, and particularly with Mr. Finley of Pittsburgh, hesitancy on his part to take any decided stand. This was greater perhaps because of having to deal with a

water supply himself in which the B. coli content perhaps regularly exceeds the limit I have just spoken of. That is the reason there is no committee report here today, and why the summary I prepared as to "Limitations of Water Filters" appears in your advance papers under my own name.

I am proposing it as a very helpful topic, I believe, for discussion, and one which should bring forth data from the various water works in this country where data are available. It is a very capricious proposition for a man to take a published report and try to draw correct conclusions as to how the water supply of any city would measure up by some summarized statement of analyses. In the first place, we don't know what the analyses are in point of procedure, do not know the thoroughness with which the particular method may be carried out, and there is considerable uncertainty in some cases as to the frequency with which the samples are analyzed. So we have decided to put forth this individual paper, which is given under my name. I have in my pocket a statement by Mr. Finley of this committee, which, if agreeable, I might read.

I think I have already stated my desire to see further record made in this country of the actual conditions of unpolluted water, based on comprehensive analyses, and I certainly am in favor of going slowly as regards the adoption of what seems to be the yardstick of the International Joint Commission, as a general yardstick throughout the various water courses of this country.

This discussion of Mr. Finley's is one which I talked over with him with some care. I believe it is a very level-headed statement of those who are actually working with waters that are more difficult to handle, more polluted than indicated by this yardstick.

It is probably unnecessary for me to point out that this question has a backhanded reference and relationship to the problem of sewage disposal. It takes in a pretty broad municipal problem in dealing with an equating of the qualities of the two problems, sewage disposal from the standpoint of protec-

tion of water supply, and the other to deal with the question of filtration, and say what is a reasonable limit for pollution, and beyond which there are some risks taken in protecting the public health of a community where the water filters may at times be subjected to mishaps or lack of attention. It is only fair to say that there is some conflict of viewpoint between those men who, connected with boards of health, are dealing with the medical side of this problem, and the engineers who are associated with the municipal water works in this country.

The advisers of this Joint Commission, who are regularly in charge of their investigations of the boundary waters—I refer particularly to Dr. Allen J. McLaughlin, just appointed State Health Commissioner for Massachusetts—I think his point is that water supplies should not be polluted within fifty per cent. of the extent indicated by the yardstick I have just set forth in detail. On the other hand, the engineers are disposed to think this is rather conservative, and if they had their own way, I am inclined to think the majority would agree with Mr. Finley that that limit is too rigid. My own viewpoint is in general sympathy with Mr. Finley as a general proposition, but I believe you must set forth standards fully as high as can be readily maintained in the majority of instances, and then allow exceptions to come forward, or what the Local Government Board in England has proposed for more than a generation, that is, to allow for certain specific propositions a lessening of the requirements, all of which are treated under what the English speak of as relaxation. That is, they do not uniformly apply in hard and fast manner these rules which you can find set forth in very brief form.

We also found our Canadian friends were disposed to look at this broad problem in this light. They said the American waterways on the Canadian side are large, the population is scattered, and there is an excellent opportunity afforded them for keeping the pollution down to limits far less than characterized waterways in the United States. They spoke of instances, little towns of perhaps five thousand on the Great

Lakes, where they were suffering a great deal from typhoid fever, even where hypochlorite of lime and methods of sterilization were adopted. That was true of cases where during daylight hours the plants were managed with care, but at night, where pumping took place, in some instances only under exceptional conditions, it was found, when pumping was resorted to, that the sterilization procedures were allowed to lapse, and the records of typhoid fever showed very little improvement over what was shown in the days prior to any sterilization methods. In other words, if during a period of one, two or three hours during a month polluted water was sent into the mains, there seemed as much trouble as though bad water were sent continually into the mains. The Canadian sanitarians are very firmly of the opinion that the raw water should be kept in as unpolluted a condition as ordinary financial exploitation of sewage disposal would permit. Mr. Finley, a member of this committee, sends the accompanying discussion, which is really a terse summary of his viewpoint on this general question I have been speaking on. I think that it is a very good summing up of the practical aspects of this problem. (Applause.)

Mr. Finley's paper will be found on page 435.

The President: We have one more paper, on "Municipal Financing," with forms for reports used in the departments of the City of Hamilton, Ontario, by Mr. A. F. Macallum, City Engineer.

Mr. Macallum: The paper was sent in, but was taken away by Mr. Lewis. It has only to do with standard forms, and will be printed.

The paper will be found on page 403.

Mr. Campbell: With reference to explosions in sewers, Mr. Sprague read an interesting paper, and the thought comes to me whether that subject is not of sufficient importance that a committee be appointed to report at the next meeting on sewer

explosions, giving roughly a tabulation of what has occurred during the year, and what steps for prevention, if any, have been taken.

THE PRESIDENT: I believe that might be taken care of by the Committee on Sewers.

MR. CAMPBELL: Then I will move that the Committee on Sewers be instructed to take that phase of the question up as part of their work for the ensuing year.

Seconded by Mr. Howard, and carried.

MR. FOLWELL: It may be an opportune time to bring this matter up, impressed upon me because of my experience as Secretary. Each year two out of three chairmen of committees appointed, who have not previously been chairmen, will write to the Secretary and ask what they are expected to do, and I had almost a stereotyped letter to send out to them, and in fact the last year or two I sent the letter out without waiting for the inquiry. I had to use my own judgment in connection with it, because there is nothing in the constitution as to that. It would seem desirable to get into definite and concrete form just what these committees should do. That can be done now better than it could five years ago because of the experience and evolution of the Society. Some of the committees overlap a little, and certain territory is perhaps not covered by any committee. I will move that the President appoint a temporary committee of three to define and co-ordinate the duties of the existing standing committees, and thus put in some stated form what might be called a set of instructions, general instructions, to the committees at large, and specific instructions to each committee as to what they are to do, one of the objects being not only for this general committee to state what already is the general practice, but to give study to the entire subject matter, to see whether the manner in which these subjects are presented to the Society cannot be improved upon, whether the committee have been doing the best that can be done, not because of disinclination, but because of not knowing

what to do; to study the whole matter, evolve some general basic principles by which the whole field of our Society can be best covered, formulate this in a set of instructions for each committee, and present this at the next annual meeting.

MR. MATTHEW BROWN: I will second that.

MR. RANKIN: Couldn't the Executive Committee take care of that?

THE PRESIDENT: I don't believe it could. I really believe it would be best to turn this over to a special committee.

Carried.

THE PRESIDENT: I will appoint to compose that committee Messrs. Folwell, Rankin and C. C. Brown.

THE SECRETARY: The Association has given instruction that these specifications be printed as soon as possible, and the question arises whether it would not be well to copyright them. Then permission would be given to any city to use them, and they would not be used by any one but the cities of the country, and would not be used for advertising purposes.

MR. HOWARD: I move that be done.

Seconded by Mr. Snyder, and carried.

MR. SNYDER: It would be well if the specifications might be printed separately, so that if any one wanted a certain part of them, he would not have to purchase all of them. Some years ago I was a member of another society, and we wanted to adopt your sewer specifications. We needed ten copies, but couldn't get them except by buying the whole book of specifications.

MR. FOLWELL: When our specifications came out, some of the colleges got copies, and asked that their students purchase copies, to be used practically as textbooks. I don't know any better way of securing their general adoption, for when a man is handed these by his professor in college as standard specifications, he will think of them in that light and use them after he leaves college. I believe Mr. Snyder's suggestion is good.

If we copyright them, it would be well to have a statement that cities wishing to use the specifications on public work are given permission to do so. Otherwise the cities might think they could not use them.

THE PRESIDENT: That is the intention. That was done with the A. S. P. S. specifications. We took the matter up with Prof. Blanchard yesterday, and he thought we had better publish them in book form. The subject of price came up, and we suggested $5, but he thought we should reduce it to $2. I see no reason, however, why we can't have some printed in book form, and have some of them separate also, printed in pamphlet form.

MR. HOWARD: I would suggest printing them separately, and making a pro rata price on the pamphlets.

THE SECRETARY: That can easily be done, and they can be bound together, or left separate. There are eight of them, and the price of 25 cents apiece would make the whole eight cost $2.

MR. HOWARD: I move that course be adopted.

Seconded by Mr. White, and carried.

MR. HOWARD: Specifications on wood block have not been adopted. If it goes in the book, the student may think it is fairly near final, while there may be great changes made. I would suggest, as our association has no specifications for the present, that we add a note to the bottom of this one, that ad interim until the next convention the wood specifications of the A. S. P. S. be used.

MR. SPRAGUE: I believe this should come through the Committee on Specifications.

MR. TILLSON: I have a resolution I would like to present. I was asked to present it by Mr. Smith of the Asphalt Committee.

Moved, That a technical committee be appointed by the President consisting of five members whose function it shall be to invite and direct the co-operation of all chemists dealing

with bituminous materials for the purpose of further standardizing present methods of testing and for the purpose of encouraging and developing additional methods and appliances for valuating paving bitumens. This committee shall be permanent for a period of four years and shall report to the general organization at each meeting.

MR. TILLSON: I believe this is a good resolution, and will move its adoption.

MR. HOWARD: I will second that. Asphalt testing has practically stood still for seven years, and I think this is a splendid thing.

Carried.

THE PRESIDENT: We will now have report of the Committee on Resolutions.

Before the Society closes its meeting today, we would propose a very hearty vote of thanks to the City of Boston and its officials, Mr. James M. Curley, Mr. Joshua Atwood, Mr. James H. Sullivan, Mr. James B. Shea, Mr. John Grady, and to Col. W. D. Sohier, Mr. John M. McCarthy, Warren Brothers Company, Mr. E. W. Pimm for the perfection of the arrangements for this convention and the splendid way in which these arrangements were carried out.

We would propose a very hearty vote of thanks to Mr. and Mrs. Larz Anderson for the delightful way in which they entertained the members and their lady friends during this convention.

We would propose a very hearty vote of thanks to Mrs. James J. Storrow for the delightful way in which she entertained the ladies during this convention.

We would propose a very hearty vote of thanks to Mrs. George C. Warren for the delightful way in which she entertained the ladies during this convention.

To those of us who have attended several conventions, it is safe to say that seldom have we enjoyed one so well, not only in the way we have been entertained by these gentlemen and

ladies, but also for the privilege of visiting places we would not otherwise have, and certainly not under such favorable circumstances. It is to express our appreciation of their efforts on our behalf that we propose this most sincere vote of thanks.

A. F. MACALLUM, *Chairman.*

MR. HOWARD: I move the adoption of the committee's report.

Seconded by Mr. Potter, and carried unanimously.

THE PRESIDENT: This concludes the work of the convention, and in turning this office over to my successor I wish to thank you, one and all, for the kind consideration and assistance you have given me during this convention. If what has been done will accomplish even a small portion of that for which the Society was organized, we will all be amply repaid for our efforts. I hope you will give to the incoming President the same consideration and hearty support you have given to me. I will now call him to the chair.

PRESIDENT-ELECT HOWELL: In assuming the chair I want to congratulate the retiring President on having had here one of the most successful conventions in the history of the Society. I have been in attendance at nine conventions, and I believe we have had as fine a time here as we ever had. The attendance has been large, there have been more papers, and very fine papers have been presented, there has been more interest in each session, and if the convention of 1915 is as interesting as this has been, I shall be entirely satisfied.

THE SECRETARY: Last year we had the largest registration at Wilmington that we had ever had. This year we beat last year's registration by two, so this is the best convention ever held.

MR. TILLSON: I want to move a vote of thanks to the retiring President for his hard work during the year, and for the

able and equitable way in which he has presided at this convention.

Seconded by Mr. Matthew Brown, and carried.

PRESIDENT HOWELL: Is there any further business to come before the convention? If not, I will now declare the Society adjourned, to meet in Dayton, Ohio, in 1915.

ATTENDANCE AT CONVENTION,

BOSTON, MASS.

Adams, Arthur A.
Allen, William
Atwood, Joshua
Babcock, C. E. P.
Baker, John, Jr.
Baker, M. N.
Baker, William D.
Barbour, F. A.
Barrett, George S.
Bartholomew, Harland
Bayliss, C. W.
Beistle, M. J.
Berger, Louis H.
Beyer, William A.
Biertuempfel, Albert
Blackburn, W. T.
Blair, Will P.
Blanchard, Arthur H.
Bosworth, A. M.
Brown, Charles Carroll
Brown, Mrs. Charles Carroll
Brown, E. L.
Brown, Matthew
Bruff, A. C.
Bryant, E. W.
Bryant, L. F.
Bull, Irving C.
Calef, M. T.
Campbell, John
Cannon, Sylvester Q.
Cannon, Mrs. Sylvester Q.
Carpenter, A. D.
Carpenter, George A.
Cellarius, Fred J.
Challar, W. T.
Chausse, Alcide
Chavis, Harry
Christ, Edward H.
Christy, Leslie V.
Church, S. R.
Clark, F. H.
Clark, H. S.
Clark, William J.
Cogen, P. S.
Collier, H. L.
Compton, R. Keith
Conant, Augustus B.
Conant, E. R.
Conant, Luther, Jr.
Connell, W. H.
Conway, W.
Cook, Thomas F.
Corson, S. Cameron
Cosgrove, Frederick A. S.
Costello, A. B.
Costello, J. J.
Craven, William D.
Crocken, J. B.
Crossett, Frederick M.
Cunliff, Nelson
Cutcheon, L. D.
Curley, James M.
Cutter, Frank G.
Cutter, Mrs. Frank G.
Daley, E. W.
Dalton, E. Leon
Dean, A. W.
Dilbert, H. M.
D'Olier, William L.
Dow, A. W.
Draney, J. R.
Drinker, L. P.
Driscoll, Michael
Dunn, F. B.
Dunn, Mrs. F. B.
Durborn, John
Dutton, Ellis R.
Eddy, Harrison P.
Elwood, Frederick T.
Emmons, B. C.
English, Joseph E.
Farr, Fred
Fay, Frank T.
Fisher, Edwin A.
Folwell, A. Prescott
Ford, F. L.
Ford, Mrs. E. L.
Forrest, C. N.
Forrester, J. D.
Foss, George H.
Fuller, George W.
Fuller, Mrs. George W.
Gartland, John J., Jr.
Gauvreau, Jos.
Giddings, Fred
Giles, John A.
Gillen, Charles P.
Gillum, H. J.

Goodell, John M.
Goodman, Frank
Graham, Charles S.
Granger, B. F.
Granger, Mrs. B. F.
Hale, Harris E.
Hall, Arthur P.
Hallock, J. C.
Hallock, Mrs. J. C.
Hammond, George T.
Hansen, Paul
Hardee, W. J.
Harris, Harry F.
Headley, W. T.
Hempelmann, W. L.
Hennesay, James P.
Hildreth, H. V.
Hodgdon, J. B.
Holbrook, I. L.
Holden, F. B.
Horn, J. Merrick
Houghton, Miss Lucy
Howard, J. W.
Howe, Miss M. S.
Howe, W. B.
Howe, Mrs. W. B.
Howell, Carl L.
Howell, William A.
Hume, S. W.
Hvass, B. C.
Inge, R. G.
Ingram, G. M.
Jennison, H. G.
Jones, R. A.
Judge, J. A.
Kendall, T. R.
Kendrick, Julian
Kennedy, D. A.
Kershaw, W. H.
Keyes, John M.
Killen, Clarence G.
Kinney, William M.
Kirschbraun, L.
Kleeberg, Felix
Knowlton, Howard S.
Lacy, Daniel S.
Lamson, George W.
Launber, Arthur
Lenderink, A.
Lenderink, Mrs. A.
Leonard, G. S.
Levering, W. A.
Levering, Mrs. W. A.
Levinson, H.
Lewis, Nelson P.
Lothrop, G. W.
Lothrop, Howard
Loud, H. S.
Macallum, A. F.
MacDonald, James H.
MacGregor, R. A.
Mahr, Herman W.
Manning, F. L.
Marks, W. J.
Martin, J. L.
McAvoy, John C.
McCarthy, J. M.
McCrea, E. W.
McDonough, Martin E.
Medfield, Edwin V.
Meriwether, B. B.
Meriwether, Coleman
Merrill, W. C.
Merrill, Mrs. W. C.
Miller, B. F.
Miller, Mrs. B. F.
Miner, Joshua L.
Morris, Jay E.
Murphy, Matthew D.
Myers, George W.
Naberhuis, H. A.
Neal, E. B.
Neal, J. F.
Needham, Charles A.
Nicholson, Maury
Norton, George N.
Osborn, Irwin S.
Parker, E.
Parker, G. A.
Parker, Philip S.
Parmley, Walter C.
Parsons, S. A.
Pearse, George E.
Peirce, George H.
Perkins, G. H.
Pierce, Herbert W.
Pierson, Frank W.
Pilcher, W. B. C.
Pimm, Earle W.
Plummer, S. B.
Pollock, Clarence D.
Pond, R. W.
Poore, H. C.
Portenheimer, John H.
Potter, Alexander
Potter, H. K.
Powell, H. L.
Preston, J. M.
Price, Charles P.
Rablin, John R.
Rankin, E. S.
Ramsay, J. E.
Reed, Alexander
Reed, Mrs. Alexander
Reid, Hugo
Reid, V. H.

Reimer, Frederick A.
Reimer, Mrs. Frederick A.
Renton, J. D.
Reppert, Charles M.
Richardson, B. F.
Richardson, Clifford
Richardson, Fred B.
Richardson, J. F.
Richer, L. N.
Robinson, E. M.
Rourke, L. K.
Rowley, H. W.
Rudolph, Charles A.
Ruxton, E. J.
Sands, E. E.
Sargent, Edward C.
Schaefer, H. G.
Schmidt, H. H.
Schutte, Karl
Schuyler, Mont.
Semple, William J. C.
Sharples, Philip P.
Shedd, E. M.
Sherman, Charles W.
Sherman, Hubert L.
Sherrerd, M. R.
Sherrerd, Mrs. M. R.
Sibley, Miss Gladys
Sibley, L. B.
Sibley, Mrs. L. B.
Smith, Francis P.
Smith, J. J.
Smith, W. Stuart
Smith, Mrs. W. Stuart
Snyder, F. A.
Sobier, William D.
Sparks, George W.
Spencer, Herbert
Sprague, Norman S.
Stanton, Mrs. A. P.
Steele, George D.
Stevens, George M.
Strother, O. G.
Sylvester, E. W.
Talbott, H. M.
Talbott, K. H.
Taylor, Alexander J.
Teesdale, Clyde H.
Thompson, S. C.
Tillson, George W.
Tomlin, Robert K., Jr.
Turner, R. W.
Tuteweiler, Franklin H.
Van Buren, James B.
Vandewater, J. A.,
Very, Edward D.
Wade, Edward C.
Warren, George C.
Warren, H. M., 2nd.
Warren, Ralph L.
Watson, R. M.
Welborn, M. C.
Welti, A. E.
Wender, W. B.
Wentworth, Franklin H.
Wentworth, R. A.
Wern, Gust. Pers.
Weston, Robert Spurr
Whipple, G. C.
Whipple, Mrs. G. C.
White, Linn
Whitehouse, John S.
Williams, John A.
Winchester, Mark
Winsor, Burr
Wolstenholms, Albert
Woodburn, William F.
Worcester, R. J. H.
Wright, Mrs. May Tucker
Wright, W. E.

CONSTITUTION OF THE SOCIETY.

ARTICLE I—Name and Object.

Section 1. The objects of this Society, which shall be known as "The American Society of Municipal Improvements," shall be to disseminate information and experience upon, and to promote the best methods to be employed in the management of municipal departments, and in the construction of municipal works, by means of annual conventions, the reading and discussion of papers upon municipal improvements, and by social and friendly intercourse at such conventions; and to circulate among its members, by means of an annual publication, the information thus obtained.

ARTICLE II—Membership.

Section 1. Any engineer, officer or director who shall have charge or supervision over, or be employed as a consulting engineer on any public, municipal, county, or state department work, or any mayor, councilman or other municipal official in any municipality, is eligible to active membership in this Society.

Any member who shall have ceased to have charge or supervision of any public or municipal department or work may, if he so elect, retain his active membership, unless he shall have come under the restrictive requirements of associate membership, when he shall retain membership as an associate only. Decision as to the classification or change in classification of all members shall rest with the Executive Committee; but an appeal may be taken from such decision to the Society at any regular annual meeting.

Sec. 2. Every application for membership shall be in writing, stating the age and residence of the applicant, his official position and past experience in municipal work.

Every application shall be considered by the Executive Committee within two months of its receipt by the Secretary. A two-thirds vote of the committee shall be necessary for election. In case of the rejection of an applicant by the committee, he may appeal to the Society at the next annual convention, when a two-thirds vote of all the active members voting shall admit him to membership.

Sec. 3. Any proper person interested in municipal improvements or work as a contractor or contracting agent or who is a manufacturer of or dealer in municipal supplies, may become an associate member, who shall enjoy all the rights and privileges of active membership, excepting that of holding office, voting or addressing the convention without its consent.

SEC. 4. Any one interested in the subject of municipal improvements, but not included in either of the above classes of members may be Such members shall enjoy all the admitted as an affiliated member. rights and privileges of active membership, excepting that of holding office or voting.

SEC. 5. Any municipality may become a municipal member of this Society and be entitled to representation at the annual conventions by such number of active members as it may desire; such active members to be entitled to all the privileges of active members.

SEC. 6. Any member who shall be in arrears for more than one year's dues may be considered as no longer a member of this Society, and his name may be discontinued from the roll of the Society at the discretion of the Executive Committee.

SEC. 7. Any member may withdraw from the Society upon payment of all dues to date, and by notifying the Secretary thereof in writing.

SEC. 8. Any member may be expelled from the Society at a regular meeting of the same, upon the recommendation of the Executive Committee, adopted by a two-thirds vote of all the active members voting.

ARTICLE III—FEES AND DUES.

SECTION 1. Each active and each affiliated member shall pay five dollars per annum, and each associate member shall pay ten dollars per annum, all dues to be payable in advance, on or before the date of the annual meeting; except that if more than one representative of a given company be members, one shall pay a fee of ten dollars, and the others five dollars each. A member admitted after March 15th of any year shall pay, for the balance of the year, one-half the annual dues. Each municipal member shall pay for each of its enrolled delegates five dollars per annum.

ARTICLE IV—OFFICERS.

SECTION 1. The officers of this Society shall consist of a President, three Vice-Presidents, a Secretary, and a Treasurer, not more than two of whom shall be residents of the same state; and who, with the past Presidents who have retained their continuous membership, shall act as an Executive Committee for and in behalf of the Society.

SEC. 2. There shall also be elected a Finance Committee consisting of three members of the Society.

SEC. 3. In case of any of the above positions, excepting the Presidency, becoming vacant, or in case of their absence during the annual convention, the President shall fill such vacancy by appointment from the membership.

SEC. 4. There shall be appointed annually the following standing committees:

1. Street Paving.
2. Street Lighting.
3. Waterworks and Water Supply.
4. Sewerage and Sanitation.
5. Disposition of Garbage and Street Cleaning.
6. Park Development and Maintenance.
7. Municipal Legislation and Finance.
8. Municipal Data and Statistics.
9. Standard Specifications.
10. Standard Forms.
11. Convention Papers.
12. Convention Arrangements.

The chairman of the last named committee shall be a resident of the city in which the next following convention is to be held, provided there is a member of the Society residing in that city.

The number of each committee shall be three, and the chairman may add such names as he may deem advisable. No special or standing committee shall be authorized to create any liabilities unless the same shall have been first approved by the Executive Committee.

ARTICLE V—ELECTION.

SECTION 1. The officers of this Society shall be elected by ballot on the second day of each annual convention, a majority of the votes cast electing.

SEC. 2. The President shall not be eligible for immediate re-election (except by a unanimous vote).

SEC. 3. The officers elected shall assume office immediately after the close of the annual meeting at which they were elected.

SEC. 4. The ballot for any officer may be waived by unanimous consent.

ARTICLE VI—DUTIES.

SECTION 1. The President shall preside at the meetings of the Society and at those of the Executive Committee, and shall perform such other duties as are incumbent upon the office. In the absence of the President, or upon his becoming ineligible, the senior Vice-President shall assume and perform the duties of the office.

SEC. 2. The Secretary shall keep accurate minutes of the proceedings of the Society and of the Executive Committee; shall conduct all correspondence; shall issue notices of any meeting of the Society not less than

four weeks prior to the date of such meeting; shall collect and receipt for all fees and dues and pay them to the Treasurer, taking his receipt for the same; and keep accurate account between the Society and its members.

He shall keep an accurate list of the members of the Society, and take such steps as may be necessary to secure new members—this with a view of insuring the permanency of the association, as well as maintaining and increasing the membership thereof.

The Secretary shall receive a salary, the amount of which shall be determined by the Executive Committee. In addition, his expenses incurred in attending conventions of this Society shall be paid by the Society; and he is authorized to incur in the name of the Society, the expenses necessary to the conduct of his office, including an assistant during the convention.

SEC. 3. The Treasurer shall receive from the Secretary and safely keep all moneys belonging to the Society, giving his receipt therefor; shall pay all bills by vouchers countersigned by the President and Secretary; shall keep correct account of the funds of the Society, and submit to it at its annual meeting a report of all receipts and disbursements during the preceding year.

SEC. 4. The Executive Committee shall manage all the affairs of the Society, subject to the action and approval of the Society at its meetings. All questions in Executive Committee shall be decided by a majority vote, and five members shall constitute a quorum, not less than four of whom shall be the officers of the Society. The Executive Committee shall meet at least once each year on the morning of the first day of the annual meeting of the Society, and as much oftener as the President may determine.

SEC. 5. The Finance Committee shall meet on the morning of the first day, and previous to the annual meeting of the Society, to examine and audit the Secretary's and Treasurer's accounts and annual statements, and report thereon to the Society.

SEC. 6. It shall be the duty of each of the standing committees, Nos. 1 to 9, inclusive, to prepare a report and submit the same at the annual meeting. Also to obtain for presentation at the meetings, papers on the subjects covered by said committee. The Committee on Convention Papers shall exercise such supervision over the papers presented as may be defined by the By-Laws. The Committee on Convention Arrangements shall have charge of the details of the convention next following the appointment of said committee, subject to the provisions of this Constitution, the By-Laws and the instructions of the Executive Committee.

ARTICLE VII—Meetings.

Section 1. The annual meetings of the Society shall be held in such city as the majority of the members voting shall decide; selection of place of meeting to be made after the officers shall have been elected. The date and duration of the meeting shall be determined by the Executive Committee, which shall notify the members concerning the same not later than the first of June; but such date shall be in either September, October or November.

Sec. 2. At any annual meeting of the Society twenty members shall constitute a quorum for the transaction of business.

Sec. 3. Any member, with the concurrence of the presiding officer, may admit friends to the meeting of the Society; but such person or persons shall not without the consent of the meeting be permitted to take part in any discussion.

Sec. 4. All papers, drawings, etc., submitted to the meeting of the Society shall be and remain the property of the Society.

ARTICLE VIII—Order of Business.

Section 1. At the annual meeting of the Society the order of business at the first session shall be as follows:

1. The President's address.
2. Reports of the Secretary and Treasurer.
3. Report of the Executive Committee.
4. Report of the Finance Committee.
5. Reports of Special Committees.
6. Reading and Discussion of Papers.

Election of officers and selection of the place of meeting shall take place during the second day.

Sec. 2. All questions shall be decided by vote, and all differences of opinion in regard to points of order shall be settled by parliamentary practice as set forth in Cushing's Manual.

ARTICLE IX—Amendments.

Section 1. The foregoing constitution and articles may be amended on or after the second day of any annual meeting of the Society by a two-thirds vote of all members voting; provided such proposed amendment shall have been submitted to the Society in writing on the first day of its annual meeting.

OFFICERS OF THE SOCIETY FOR THE YEAR 1914-1915

President..............WILLIAM A. HOWELL.........Newark, N. J.
First Vice-President...A. F. MACALLUM.............Hamilton, Ont.
Second Vice-President.NORMAN S. SPRAGUE........Pittsburgh, Pa.
Third Vice-President..E. L. DALTON.................Dallas, Tex.
Secretary..............CHARLES CARROLL BROWN..Indianapolis, Ind.
Treasurer.............WILL B. HOWE.................Concord, N. H.

Finance Committee

F. J. CELLARIUS..........................Dayton, Ohio
L. V. CHRISTY..............................Wilmington, Del.
R. KEITH COMPTON......................Baltimore, Md.

Executive Committee

The officers of this Society, together with the Past Presidents who have retained their continuous membership, constitute the Executive Committee. The Past Presidents are as follows:

Past Presidents

M. J. MURPHY............................St. Louis, Mo.
GEORGE H. BENZENBERG...............Milwaukee, Wis.
AUGUST HERRMANN ....Cincinnati, Ohio
HARRISON VAN DUYNE................Newark, N. J.
NELSON P. LEWIS........................New York, N. Y.
A. D. THOMPSON........................Peoria, Ill.
ROBERT E. McMATH.....................St. Louis, Mo.
E. A. FISHER.............................Rochester, N. Y.
C. H. RUST................................Victoria, B. C., Can.
GEORGE M. BALLARD (Deceased).......Newark, N. J.
A. PRESCOTT FOLWELL................New York, N. Y.
CHARLES C. BROWN.....................Indianapolis, Ind.
MORRIS R. SHERRERD..................Newark, N. J.
GEORGE W. TILLSON....................Brooklyn, N. Y.
JAMES OWEN ....Newark, N. J.
JULIAN KENDRICK ....Birmingham, Ala.
FRED GIDDINGS ....New Orleans, La.
E. A. KINGSLEY...........................Little Rock, Ark.
B. E. BRIGGS..............................Erie, Pa.
EDWARD H. CHRIST......................Grand Rapids, Mich.

STANDING COMMITTEES, 1914-1915

Street Paving

FREDERICK A. REIMER, *Chairman*......Newark, N. J.
B. E. BRIGGS..........................Erie, Pa.
R. KEITH COMPTON....................Baltimore, Md.
F. W. CAPPELEN.......................Minneapolis, Minn.
FRANK R. LANAGAN...................Albany, N. Y.
J. B. McCALLA.........................Knoxville, Tenn.

Traffic on Streets

LOUIS L. TRIBUS *Chairman*..............New York City
HENRY MAETZEL ....Columbus, Ohio
JAMES W. HOWARD....................New York City

Street Lighting

JAMES C. HALLOCK, *Chairman*...........Newark, N. J.
ALBERT H. BIERTUEMPFEL............Newark, N. J.
F. G. LYNCH...........................Erie, Pa.

Water Works and Water Supply

CARLETON E. DAVIS, *Chairman*.........Philadelphia, Pa.
PAUL HANSEN ....Urbana, Ill.
E. E. LAMPHER.........................Pittsburgh, Pa.

Sewerage and Sanitation

GEORGE H. NORTON, *Chairman*..........Buffalo, N. Y.
R. C. HARRIS...........................Toronto, Ontario, Canada
HENRY N. OGDEN......................Ithaca, N. Y.

Garbage Disposal and Street Cleaning

JOHN T. FETHERSTON, *Chairman*.......New York City
ELBRIDGE R. CONANT..................Savannah, Ga.
B. F. MILLER, JR.......................Meadville, Pa.

Park Development and Maintenance

GEORGE A. PARKER, *Chairman*..........Hartford, Conn.
H. S. RICHARDS.........................Chicago, Ill.
HARLAND BARTHOLOMEW............Newark, N. J.

Municipal Legislation and Finance

ARTHUR R. DENMAN, *Chairman*.........Newark, N. J.
GEORGE W. SPARKS.....................Wilmington, Del.
F. H. FRANKLAND.......................St. Charles, La.

Fire Prevention

ALCIDE CHAUSSE, *Chairman*.............Montreal, Quebec, Canada
JOHN H. McCABE.........................Detroit, Mich.
L. C. WILLIS...............................Dallas, Tex.

Standard Forms

A. PRESCOTT FOLWELL, *Chairman*......New York City.
CLARENCE D. POLLOCK................New York City.
MAURY NICHOLSON ....Birmingham, Ala.

Sub-Committees on Standard Forms

STREET CLEANING AND REFUSE DISPOSAL

J. T. FETHERSTON.......................New York City.

STREET LIGHTING.

G. A. SAWIN...............................Newark, N. J.

SIDEWALKS AND CURBS

HARRY F. HARRIS.......................Trenton, N. J.

SEWER CONSTRUCTION AND MAINTENANCE

E. S. RANKIN...............................Newark, N. J.

Standard Specifications

GEORGE W. TILLSON, *Chairman*.........Brooklyn, N. Y.
E. A. FISHER..............................Rochester, N. Y.
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HENRY C. ALLEN........................Syracuse, N. Y.
JOHN B. HITTELL.......................Chicago, Ill.

Sub-Committees on Standard Specifications

WOOD BLOCK PAVING

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A. W. DOW.................................New York City.
J. H. WEATHERFORD....................Memphis, Tenn.
W. P. TAYLOR............................Philadelphia, Pa.
GEORGE W. TILLSON....................Brooklyn, N. Y.
CURTIS HILL ....Kansas City, Mo.

BRICK PAVING

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HENRY MAETZEL ....Columbus, Ohio
S. CAMERON CORSON...................Norristown, Pa.
H. K. McCAY...............................Baltimore, Md.
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BITUMINOUS PAVING

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J. C. HUGHES............................Tulsa, Okla.
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ASPHALT PAVING

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LESTER KIRSCHBRAUN ....Chicago, Ill.
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R. KEITH COMPTON....................Baltimore, Md.
JOSHUA ATWOOD ....Boston, Mass.
J. M. PRESTON..........................Dallas, Tex.
MATTHEW BROWN ....Emporia, Kan.
JAMES C. HALLOCK.....................Newark, N. J.

CONCRETE PAVING

WILLIAM J. HARDEE, *Chairman*.........New Orleans, La.
H. L. SHANER............................Lynchburg, Va.
H. G. LYKKEN...........................Grand Forks, N. D.
W. W. CROSBY..........................Baltimore, Md.
WATSON TOWNSEND ....Omaha, Neb.
T. M. REED...............................Pittsburgh, Pa.
C. E. P. BABCOCK.......................Buffalo, N. Y.

STONE BLOCK PAVING

H. H. SCHMIDT, *Chairman*................Brooklyn, N. Y.
M. R. SHERRERD.........................Newark, N. J.
J. E. RAMSEY.............................Salisbury, N. C.
GEORGE A. CARPENTER................Pawtucket, R. I.
JOHN B. HITTELL.......................Chicago, Ill.
NORMAN S. SPRAGUE..................Pittsburgh, Pa.
S. C. THOMPSON........................New York City.
R. A. MacGREGOR.......................New York City.
FRED T. ELWOOD.......................Rochester, N. Y.

BROKEN STONE AND GRAVEL ROADS

A. H. BLANCHARD, *Chairman*.............New York City.
W. H. CONNELL..........................Philadelphia, Pa.
FREDERIC A. REIMER...................Newark, N. J.
A. J. LENDERINK........................Kalamazoo, Mich.
R. A. MacGREGOR.......................New York City
PREVOST HUBBARD ....Washington, D. C.
THOMAS H. BRANNAN..................Columbus, Ohio
W. W. CROSBY...........................Baltimore, Md.

SEWERS

E. J. FORT, *Chairman*........................Brooklyn, N. Y.
RUDOLPH HERING ....New York City.
A. J. PROVOST, JR.........................New York City.

Convention Papers

CHARLES C. BROWN, *Chairman*..........Indianapolis, Ind.
A. PRESCOTT FOLWELL................New York City.
B. E. BRIGGS.............................Erie, Pa.

Convention Arrangements

JAMES E. BARLOW, *Chairman*............Dayton, Ohio
CHARLES C. BROWN....................Indianapolis, Ind.
A. PRESCOTT FOLWELL................New York City

Convention Exhibits

F. J. CELLARIUS, *Chairman*...............Dayton, Ohio
F. L. MANNING............................Portsmouth, Ohio
B. F. GRANGER............................Jackson, Mich.
JAMES E. BARLOW.......................Dayton, Ohio
FRANK G. CUTTER.......................Chicago, Ill.

SPECIAL COMMITTEES

Committee on Sidewalks

WILLIAM D. WILLIGEROD, *Chairman*....East Orange, N. J.
H. L. SHANER............................Lynchburg, Va.
ROBERT M. WATSON.....................Rutherford, N. J.

Committee on Membership

F. J. CELLARIUS, *Chairman*...............Dayton, Ohio
ANDREW F. MACALLUM................Hamilton, Ont., Canada
B. B. MERIWETHER......................Birmingham, Ala.

Obituary Committee

JAMES OWEN, *Chairman*...................Newark, N. J.
H. H. SCHMIDT...........................Brooklyn, N. Y.
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W. A. Howell
President

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Secretary

W. B. Howe
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OFFICIALS OF THE YEAR — 1914-1915

MEMBERSHIP LIST.

ACTIVE.

Ackerman, J. Walter, Superintendent Board of Water Commissioners, Auburn, N. Y.
Adam, William Alexander, Assistant City Engineer, Lethbridge, Alberta, Canada.
Aldridge, William, Chief Computor and Estimator, City Engineering Dept., 333 McGee St., Winnipeg, Manitoba, Canada.
Allen, F. R., City Engineer, Pine Bluff, Ark.
Allin, Thomas D., Commissioner of Public Works, 208 Kendall Bldg., Pasadena, Cal.
Alvord, John W., Consulting Engineer, Hartford Building, Chicago, Ill.
Ambler, John N., Consulting Engineer for Winston, Winston, N. C.
Anderson, Clark G., Commissioner of Streets and Public Improvements, Moline, Ill.
Andrews, Horace, 125 Lancaster St., Albany, N. Y.
Anschutz, H. E. City Engineer, Box 158, Clearwater, Fla.
Ash, Louis R., 1012 Baltimore Ave., Kansas City, Mo.
Ashley, Charles S., Mayor, New Bedford, Mass.
Atwood, Joshua, Chief Engineer, Paving Service, Public Works Department, 501 City Hall Annex, Boston, Mass.
Baillairge, W. D., City Engineer, Quebec, Que., Canada.
Baker, Henry E., Consulting Engineer, Watertown, N. Y., now Hangchow, Chekiang, China.
Ballinger, John E., Engineer of Highways, Jacksonville, Fla.
Barbour, Frank A., Consulting Engineer, 1120 Tremont Bldg., Boston, Mass.
Barlow, James E., Director of Public Service, City Hall, Dayton, Ohio.
Barlow, John R., City Engineer, Montreal, Que., Can.
Bartholomew, Harland, Secretary Newark City Plan Commission, Newark, N. J.
Bayliss, J. R., Supt. of Water Works, Box 248, Jackson, Miss.
Bennett, Charles J., State Highway Commissioner, Capitol, Hartford, Conn.
Benzenberg, George H., 1310 Wells Bldg., Milwaukee.
Berry, George, Assistant Engineer, Bureau of Highways, Brooklyn, N. Y.
Biertuempfel, Albert H., Commissioner Board of Works, Newark, N. J.
Blanchard, A. C. D., care of Greater Winnipeg Water District, Winnipeg, Manitoba, Can.
Blanchard, Arthur H., Professor of Highway Engineering, Columbia University, New York City.
Boudinot, Allen R., City Engineer, Davenport, Ia.
Bradshaw, H. J., City Engineer, Abilene, Tex.
Brannan, Thomas H., Superintendent Asphalt Construction, City Engineer's Office, Columbus, Ohio.
Brennan, W. C., Secretary City Corporation, Hamilton, Ont., Can.
Briggs, B. E., City Engineer, Erie, Pa.
Brown, Charles Carroll, Consulting Engineer, Editor Municipal Engineering, 702 Wulsin Bldg., Indianapolis, Ind.
Brown, Matthew, City Engineer, 211 S. State St., Emporia, Kan.
Brown, Thurber A., 416 E. Church St., Elmira, N. Y.
Brown, William M., Chief Engineer, Passaic Valley Sewerage Commission, 820 Essex Bldg., Newark, N. J.

Buchanan, N. B., City Engineer, and Secretary Tupelo Engineering Company, Tupelo, Miss.
Bull, Irving C., care Bull & Roberts, 100 Maiden Lane, New York City.
Butler, Morgan R., City Engineer, Waukesha, Wis.
Caldwell, Wallace L., District Manager, Pittsburgh Testing Laboratory, 215 Clark Bldg., Birmingham, Ala.
Campbell, W. C., Superintendent Public Works, Columbus, Ga.
Cappelen, F. W., City Engineer, Minneapolis, Minn.
Carpenter, George A., City Engineer, Pawtucket, R. I.
Carter, Hugh R., State Highway Engineer, New State Capitol, Little Rock, Ark.
Cellarius, Frederick J., 1001 Commercial Bldg., Dayton, Ohio.
Charles, Frederic R., City Engineer, Richmond, Ind.
Chausse, Alcide, City Architect and Superintendent of Buildings, 1438 Hubert St., Montreal, Que., Can.
Christ, Edward H., Consulting Engineer, Norris Bldg., Grand Rapids, Mich.
Christy, L. V., Secretary Street and Sewer Department, Wilmington, Del.
Clark, Frederick H., Superintendent of Streets and Engineering, 328 Municipal Bldg., Springfield, Mass.
Codwise, Edward B., 298 Wall St., Kingston, N. Y.
Colby, Elmer E., City Engineer, Chickasha, Okla.
Collins, Clarke P., Civil and Mining Engineer, 809-811 Johnstown Trust Bldg., Johnstown, Pa.
Collins, John L., Village Engineer, Saranac Lake, N. Y.
Conant, Elbridge R., Chief Engineer, Savannah, Ga.
Cook, J. C., Chief Engineer The J. B. McCrary Co., Municipal Engineers, 1406 Third National Bank Bldg., Atlanta, Ga.
Coombs, Philip H., City Engineer, Bangor, Me.
Cooper, C. M., City Engineer, Columbus, Kan.
Corning, Dudley T., Assistant to Mining Engineer, C. S. Co., Supervision of Westmount Boro Improvements, Westmount, Johnstown, Pa.
Corson, S. Cameron, Boro Engineer, City Hall, Norristown, Pa.
Craig, George W., City Engineer, City Hall, Calgary, Alberta, Can.
Craver, H. H., Chief Chemist, Pittsburgh Testing Laboratory, Pittsburgh, Pa.
Crayton, G. A., care of W. J. Sherman Co., Civil Engineers, Toledo, Ohio.
Crook, J. W., City Engineer, 1704 Lamar Ave., Paris, Tex.
Crosby, Walter W., Consulting Highway Engineer, 1431 Munsey Bldg., Baltimore, Md.
Curfman, Lawrence E., City Engineer, Pittsburg, Kan.
Cutcheon, L. D., Secretary and General Manager, Board of Public Works, Grand Rapids, Mich.
Dalton, E. L., 9-10 Murphy Bldg., Dallas, Tex.
Danford, W. P., City Engineer, Durant, Okla.
Davis, Charles H., South Yarmouth, Mass.
Dean, Arthur W., Chief Engineer, Massachusetts Highway Commission, 34 Oxford St., Winchester, Mass.
De Lay, Theodore S., City Engineer, Creston, Iowa.
Denman, A. R., Chairman, Department of Water, Board of Street and Water Commissioners, 765 Broad St., Newark, N. J.
Dickey, A. T., City Engineer, Galveston, Tex.
Dingle, James H., City Engineer, City Hall, Charleston, S. C.
Dorr, Edgar S., Chief Engineer Sewer Service, 213 Savin Hill Ave. (Dorchester), Boston, Mass.
Douthitt, M. J., City Engineer, City Hall, Waukegan, Ill.
Dow, A. W., Consulting Engineer, 24-26 East 21st St., New York City.
Drane, Frank P., Paving Inspector and Supervisor, 22½ W. 5th St., Charlotte, N. C.

Driscoll, Michael, Supt. Streets and Sewers, Town Hall, Brookline, Mass.
Drowne, Henry B., Columbia University, New York City.
Duck, Allen Douglass, City Engineer, Greenville, Tex.
Earl, George G., General Superintendent, Sewerage and Water Board, New Orleans, La.
Eddy, Harrison P., Consulting Civil Engineer, 14 Beacon St., Boston, Mass.
Edgerly, R. J., City Engineer, Albany, Ga.
Ellsworth, Frank V. P., Assistant City Engineer, San Antonio, Tex.
Elwood, F. T., City Engineer, Rochester, N. Y.
Emerson, Ralph W., Assistant Engineer, City Hall, Pittsfield, Mass.
Erwin, M. C., Office Engineer O'Neill Engineering Co., Dallas, Tex.
Farnham, Arthur B., Engineer Board of Public Works, Pittsfield, Mass.
Fellows, A. Lincoln, Consulting Engineer, 435 Century Bldg., Denver, Col.
Fetherston, John Turney, Engineer of Street Cleaning, Municipal Bldg., New York City.
Finch, B. K., City Engineer, Wilkes-Barre, Pa.
Firth, Joseph, City Engineer, Charlotte, N. C.
Fisher, E. A., Consulting Engineer to City of Rochester, Rochester, N. Y.
Flenniken, John W., Commissioner Streets and Public Improvements, Knoxville, Tenn.
Fletcher, Austin B., State Highway Engineer, Forum Bldg., Sacramento, Cal.
Folwell, A. Prescott, Editor Municipal Journal, 50 Union Square, New York City.
Fort, E. J., Chief Engineer of Sewers, Boro of Brooklyn, 1013-1014 Mechanics Bank Bldg., Brooklyn, N. Y.
Frankland, Frederick Herston, Bridge Engineer Highway Department, care Highway Department Calcasieu Parish, Lake Charles La.
Freitas, George H., City Engineer, Modesto, Cal.
Fuller, George W., 170 Broadway, New York City.
Fulton, D. F., City Engineer, City Hall, Yonkers, N. Y.
Gainey, W. H., City Engineer, Valdosta, Ga.
Gardiner, W. H. R., Superintendent Public Works, 627 Fifteenth Ave., West Calgary, Alberta, Can.
Garland, E. A., City Engineer, Santa Barbara, Cal.
Gavett, Andrew J., City Surveyor and Street Commissioner, 151 North Ave., Plainfield, N. J.
Gaynor, Keyes C., 506-509 United Bank Bldg., Sioux City, Ia.
Giddings, Fred, 1104 Kirkman St., Lake Charles, La.
Giles, John A., City Engineer, Binghamton, N. Y.
Gillen, Charles P., Commissioner Board Street and Water Commission, City Hall, Newark, N. J.
Gillespie, Richard H., Chief Engineer Sewers and Highways, 2774 Briggs Ave., Bronx, New York City.
Goodell, John M., 106 Lorraine Ave., Upper Montclair, N. J.
Goodfellow, J. J., City Engineer, San Antonio, Tex.
Gorham, E. L., City Engineer, Lake Charles, La.
Greenalch, Wallace, Commissioner of Public Works, Albany, N. Y.
Gregory, Alfred C., Engineer of Sewers, 907 Bellevue Ave., Trenton, N. J.
Hackney, John W., Atlantic City, N. J.
Hale, William C., Jr., Box 1235, San Diego, Cal., Mail Returned.
Hallock, James C., Deputy Chief Engineer, City Hall, Newark, N. J.
Halsey, Edmund R., 41 Delaware Ave., South Orange, N. J.
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Hansen, Paul, Engineer Illinois State Water Survey, Urbana, Ill.
Harris, Harry F., Engineer of Streets, Trenton, N. J.
Hatton, T. Chalkley, Sewer Commissioner, Milwaukee, Wis.
Hausaling, Jacob, Mayor, Newark, N. J.
Hawkins, A. J., Resident Manager, H. S. Jaudon Engineering Co., Bartow, Fla.
Hawley, John B., Hoxie Bldg., Fort Worth, Tex.
Hayler, Guy Wilfred, Senior Draftsman, Chief Engineer's Office, South Park Commission, Chicago, Ill.
Heebink, G. E., City Engineer, Goodwin Block, Beloit, Wis.
Hennen, Robert David, Engineer for County Commissioners, Morgantown, W. Va.
Henry, P. W. 25 Broad St., New York City.
Hering, Rudolph, 170 Broadway, New York City.
Herrmann, August, Cincinnati, Ohio.
Hill, Nicholas S., Jr., 100 William St., New York City.
Hills, George B., Engineer Manager, Isham Randolph & Co., Consulting Engineers, 1310 Heard Bank Bldg., Jacksonville, Fla.
Hillyer, William R., Assistant Commissioner of Public Works, Borough of Richmond, Port Richmond, N. Y.
Hittell, John B., Chief Engineer of Streets, 207 City Hall, Chicago, Ill.
Hodges, Gilbert, Acting as City Engineer, 230 S. Main St., Franklin, N. H.
Hoff, Carl P., Assistant City Engineer, St. Joseph, Mo.
Hoffman, Robert, Chief Engineer Department of Public Service, Cleveland, Ohio.
Hohenstein, August, Purchasing Agent, City Hall, St. Paul, Minn.
Horrigan, W. J., Ford Bldg., Wilmington, Del.
Howard, J. W., Consulting Engineer, 1 Broadway, New York City.
Howe, Will B., City Engineer, Concord, N. H.
Howell, Robert P., Town Engineer, Phillipsburg, N. J.
Howell, William A., Engineer of Streets and Highways, City Hall, Newark, N. J.
Hubbard, Prevost, Consulting Chemical Engineer, 19th and B. Sts., N. W., Washington, D. C.
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Hughes, Hector James, Prof. Civil Engineering, Harvard University, 6 Clement Circle, Cambridge, Mass.
Hughes, T. C., City Engineer, Tulsa, Okla.
Iredell, George S., Civil Engineer, Austin, Tex.
Judson, William Pierson, Consulting Engineer, President Broadalbin Electric Light & Power Co., Broadalbin, Fulton Co., N. Y.
Kendrick, Julian, City Engineer, Birmingham, Ala.
Keyes, John M., Chairman Board of Road Commissioners, Chairman Board of Health, Concord, Mass.
Keyser, George D., Commissioner of Parks, Salt Lake City, Utah.
Kidd, Alexander L., District Engineer, Public Works Department, 48 Sagamore St., (Dorchester), Boston, Mass.
Kindrick, A. H., City Engineer, McAlester, Okla.
Kingsley, Edgar A., Consulting Engineer, Little Rock, Ark.
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Koiner, C. W., General Manager and Electrical Engineer, Municipal Lighting Works, Pasadena, Cal.
Kraemer, C. F., M. D., Commissioner Board of Works, City Hall, Newark, N. J.
Lanagan, Frank R., City Engineer, City Hall, Albany, N. Y.
Lea, Lucian D., City Engineer, Lead, S. D.
Lee, B. M., City Engineer, Asheville, N. C.
Lenderink, Andrew, City Engineer, Kalamazoo, Mich.
Levinson, Henry, City Engineer, Little Rock, Ark.
Lewis, J. E., General Supt., The Fred A. Jones Co., Dallas, Tex.
Lewis, Nelson P., Chief Engineer Board of Estimate and Apportionment, Municipal Bldg., New York City.
Lewis, R. J., City Engineer, Fort Madison, Ia.
Little, John C., Chief Engineer The Roland Park Co., Roland Park, Baltimore, Md.
Lovewell, Maurice N., Assistant Engineer South Park Commissioners, 57th St. and Cottage Grove Ave., Chicago, Ill.
Luster, W. H., Elizabeth, N. J.
Lykken, H. G., City Engineer, Grand Forks, N. D.
Lyman, David Russell, Chief Engineer Board of Public Works, 214 City Hall, Louisville, Ky.
Lynch, F. G., Assistant to City Engineer, Erie, Pa.
Macallum, Andrew F., City Engineer, City Hall, Hamilton, Ont., Can.
Macartney, Morton, City Engineer, Spokane, Wash.
MacDonald, James H., Road and Pavement Expert, New Haven, Conn.
MacGregor, R. A., Assistant Engineer, Bureau of Highways, Manhattan Boro, New York City.
Maetzel, Henry, City Engineer, Columbus, Ohio.
Magruder, J. O., City Engineer, Danville, Va.
Mangold, John F., City Engineer, Grinnell, Iowa.
McCabe, John C., City Boiler Inspector, 410 City Hall, Detroit, Mich.
McCalla, J. B., City Engineer, Knoxville, Tenn.
McCay, H. K., City Engineer, City Hall, Baltimore, Md.
McCrary, S. K., City Engineer, 1011 Laramie St., Atchison, Kan.
McCullough, Ernest, 2114 Fisher Bldg., Chicago, Ill.
McLean, G. T., City Engineer, Astoria, Oregon.
McNeal, John, City Engineer, Columbia, S. C.
McMath, Robert E., 327-328 Lincoln Trust Bldg., St. Louis, Mo.
Meade, R. E., 1520 Brown-Marx Bldg., Birmingham, Ala.
Meckley, Earle W., Principal Assistant Engineer, Department Streets and Public Improvements, City Engineer's Office, Allentown, Pa.
Meriwether, B. B., care Birmingham Realty Co., Birmingham, Ala.
Mesiroff, J. A., City Engineer, City Hall, Milwaukee, Wis.
Metz, L. V., Assistant to City Engineer, Erie, Pa.
Miller, B. F., Jr., City Engineer, 902 Grove St., Meadville, Pa.
Miner, Franklin M., Assistant Engineer, Street Laying Out Department, 100 Summer St., Boston, Mass.
Morrison, Roger L., Professor of Highway Engineering, A. & M. College, College Station, Tex.
Mullen, Charles A., 729 St. Ouen Place, Wakefield, Bronx, New York City.
Murphy, M. D., Street and Sewer Director, Belvedere Apartments, Wilmington, Del.
Naberhuis, H. A., 135 10th St., Miami, Fla.
Nicholson, Maury, Assistant City Engineer, City Hall, Birmingham, Ala.
Nicholson, Victor, Engineering Chemist, City of Chicago, 7621 Lowe Ave., Chicago, Ill.
Nicol, Walter H., Tuscaloosa, Ala.
Noble, O. E., City Engineer, Manhattan, Kan.

Ogden, Henry N., Professor of Sanitary Engineering, Cornell University, Ithaca, N. Y.
Ogier, James W., Asst. Engr., City Engineer's Office, Baltimore, Md.
O'Hara, Michael Joseph, Superintendent of Public Works, Hudson, N. Y.
Olmstead, Frederick L., Landscape Architect, Brookline, Mass.
Osgood, Manley, City Engineer, Ann Arbor, Mich.
Owen, James, 196 Market St., Newark, N. J.
Parent, Arthur, Superintendent City Lighting Department, Montreal, Que., Can.
Parker, George A., Superintendent of Parks, Hartford, Conn.
Parkes, William J., 203 Citizens Bank Bldg., Pine Bluff, Ark.
Parmalee, Louis R., City Engineer, Helena, Ark.
Parobek, Anastasuis, City Chemist, Trenton, N. J.
Parsons, Maurice G., 910 South Madison Ave., Pasadena, Cal.
Payton, Lyle, City Engineer, Moline, Ill.
Pealer, Thomas, City Engineer, Indiana, Pa.
Peck, Leon F., Superintendent of Streets, City Hall, Hartford, Conn.
Peterson, E. F., Muskogee, Okla.
Phul, William von, 921 Canal St., New Orleans, La.
Pierce, Herbert W., Commissioner Public Works, 26 City Hall, Rochester, N. Y.
Pierce, John Irvin, City Engineer, Jackson, Miss.
Pollock, Clarence D., Park Row Bldg., New York City.
Potter, Alexander, Consulting Civil Engineer, 50 Church St., New York City.
Preston, J. M., City Engineer, Dallas, Tex.
Provost, A. J., Jr., 39-41 West 38th St., New York City.
Prow, John C., City and County Engineer, Salem, Ind.
Quinn, Edward W., Superintendent of Streets, 19 Pleasant St., Cambridge, Mass.
Randolph, Robert Isham, Secretary-Treasurer, Isham Randolph & Co., Consulting Engineers, 1807 Commercial National Bank Building, Chicago, Ill.
Rankin, E. S., Engineer of Sewers and Drainage, Newark, N. J.
Reed, Merle H., City Engineer, Fort Smith, Ark.
Reimer, Frederic A., County Engineer, Essex County, Newark, N. J.
Reppert, Charles M., Division Engineer, Bureau of Construction, Department of Public Works, 5912 Douglas Ave., Pittsburgh, Pa.
Reynolds, A. M., Chief Engineer Essex County Park Commission, 60 Clifton Ave., Newark, N. J.
Rich, Edward D., State Sanitary Engineer, Lansing, Mich.
Richards, H. S., Assistant Superintendent South Park Commission, 5454 Greenwood Ave., Chicago, Ill.
Ridgway, Robert, Public Service Commission, 1st District, Engineer of Subway Construction, 154 Nassau St., New York City.
Riter, George W., care of Eureka Hill Mining Co., Salt Lake City, Utah.
Rogers, Niart, City Engineer, Asbury Park, N. J.
Rourke, Louis K., Commissioner of Public Works, City Hall, Boston, Mass.
Rudolph, Charles A., Street and Sewer Director, 411 Delaware Ave., Wilmington, Del.
Russell, L. M., City Engineer, 309 E. Crawford St., Elkhart, Ind.
Rust, Charles H., City Engineer, Victoria, B. C., Can.
Ruttan, H. N., Consulting Engineer to City of Winnipeg, 801-802 Confederation Life Bldg., Winnipeg, Man., Can.
Sands, Edward E., City Engineer, City Hall, Houston, Tex.
Sargent, Welland F., Commissioner of Public Works, Municipal Bldg., Oak Park, Ill.

Scattergood, E. F., Electrical Engineer, Department Public Service, 1415 Berkshire St., R. F. D. 8, No. 331 A., Los Angeles, Cal.
Schmidt, H. H., Chief Engineer, Bureau of Highways, Brooklyn, N. Y.
Semple, William J. C., Assistant City Engineer, and Engineering Division Street Laying Out Department, Boston, Mass.
Shand, Gadsden E., Columbia, S. C.
Shaner, H. L., City Engineer, Lynchburg, Va.
Sharp, John C., Engineer of Sewers, City Engineer's Office, 407 City Hall, Portland, Ore.
Shepard, Frank T., Town Engineer for Nutley and Belleville, N. J., Nutley, N. J.
Sherrerd, Morris R., Chief Engineer, Department of Public Works, Newark, N. J.
Shipman, Charles M., General Superintendent of Works, Newark, N. J.
Shockley, P. S., City Engineer and County Surveyor, News Bldg., Salisbury, Md.
Slattery, John L., Secretary-Treasurer St. Johns Municipal Council, St. Johns, Newfoundland.
Smith, Francis P., Consulting Engineer, 131-133 East 23rd St., New York City.
Smith, J. J., City Engineer, East Grand Forks, Minn.
Smoot, L. D., Chief Engineer, Jacksonville, Fla.
Snyder, Frederick Antes, Chief Engineer Town of Mount Royal, 290 St. James St., Montreal, Que., Can.
Sohier, William D., Chairman, Massachusetts Highway Commission, 15 Ashburton Place, Boston, Mass.
Sparks, George W., President Street and Sewer Board, Wilmington, Del.
Sprague, Norman S., Superintendent Bureau of Engineering, Pittsburgh, Pa.
Stallings, Robert, Paragould, Ark.
Steed, Robert E., City Clerk, 438 Fairfax Ave., Norfolk, Va.
Stevens, L. E., City Engineer, Grand Rapids, Mich.
Stevenson, John D., Assistant Engineer Bureau of Construction, in charge of North Side Office, 1231 Monterey St., North Side, Pittsburgh, Pa.
Strachan, Joseph, 352 Putnam Ave., Brooklyn, N. Y.
Sullivan, James H., Division Engineer, Public Works Department, City Hall, Boston, Mass.
Sylvester, Elbert W., City Engineer and Superintendent Public Works, Poughkeepsie, N. Y.
Talbot, A. N., Professor of Municipal and Sanitary Engineering, University of Illinois, Urbana, Ill.
Talbott, H. M., City Engineer, Owensboro, Ky.
Taylor, Alexander J., Engineer in Charge of Sewers, Wilmington, Del.
Taylor, Charles F., 604 Second National Bank Bldg., Pittsburgh, Pa.
Thomas, J. Fred, County Surveyor, Mercer Co., Farrell Pa.
Thompson, S. C., Principal Assistant Engineer, Bureau of Highways, Boro of Bronx, New York City.
Thum, William, 123 Columbia St., Pasadena, Cal.
Tillson, George W., Consulting Engineer to Boro President, Boro Hall, Brooklyn, N. Y.
Tomlinson, W. S., Principal Assistant Engineer Shand Engineering Co., Columbia, S. C.
Tribus, Louis L., 86 Warren St., New York City.
Ulrich, Edmund B., City Engineer, Reading, Pa.
Van Trump, Isaac, 2337 S. Paulina St., Chicago, Ill.
Van Zuben, Frank J., Acting City Engineer, Fort Worth, Tex.
Vosler, Ray, Acting City Engineer, Greenville and Jamestown, Box 348, Greenville, Pa.

Waite, H. M., City Manager, Dayton, Ohio.
Wasser, Thomas J., County Engineer, Court House, Jersey City, N. J.
Watson, Robert M., Boro Engineer, Rutherford, N. J.
Weatherford, J. H., City Engineer, Memphis, Tenn.
Welborn, M. C., Chief Engineer of Sewers, Austin, Tex.
Wertheim, L. J., City Engineer, in charge of Public Works, Berlin, N. H.
Weston, Robert Spurr, Consulting Sanitary Engineer, 14 Beacon St., Boston, Mass.
Wheeler, Holland, City Engineer, Lawrence, Kan.
Whipple, George C., 15 Berkeley Place, Cambridge, Mass.
White, Linn, Chief Engineer, South Park Commissioners, Chicago, Ill.
Whitney, Harrie L., City Engineer, Beverly, Mass.
Whyman, R. O., Amarillo, Tex. Mail Returned.
Willigerod, William D., City Engineer, City Hall, East Orange, N. J.
Wills, Joe B., Chief Sanitary Inspector, City Hall, Dallas, Tex.
Wilson, James, County Commissioner and State Highway Commissioner, Court House, Wilmington, Del.
Wilson, James, Superintendent of Water Works, Calgary, Alberta, Can.
Wingfield, Nisbet, City Engineer and Commissioner Public Works, Augusta, Ga.
Young, Alexander R., City Engineer, Topeka, Kan.

AFFILIATED.

Campbell, John, Superintendent Special Service Department, The Edison Electric Illuminating Co., 39 Boylston St., Boston, Mass.
Datz, L. C., Engineer of Roadway, New Orleans Railway & Light Company, 205 Baronne St., New Orleans, La.
Gould, J. W. DuB., 30 Church St., New York City.
Griffith, O. J., Treasurer and General Superintendent L. R. Ry. & E. Co., Little Rock, Ark.
Hegarty, D. A., Houston Lighting and Power Co., Houston, Tex.
Lothrop, G. W., Woonsocket, R. I.
Norman, W. H. Dallas, Tex. Mail Returned.
Sawin, George A., Electrical Engineer, Public Service Electric Co., 759 Broad St., Newark, N. J.
Slifer, William, Consulting Engineer, 413 Fourth Ave., Pittsburgh, Pa.
Teesdale, Clyde H., in Charge of Wood Preservation, Forest Products Laboratory, Madison, Wis.
Von Schrenk, Herman, Tower Grove and Flad Aves., St. Louis, Mo.

MUNICIPAL MEMBERS.

Albany, N. Y.

1914.

Wallace Greenalch.
Frank P. Lanagan.
Erwin B. Stevenson.
James R. Watt.

Baltimore, Maryland.

1914.	1915.
R. Keith Compton.	R. Keith Compton.
R. M. Cooksey.	R. M. Cooksey.
Bruce Aldrich.	H. K. McCay.
H. K. McCay.	

Binghamton, New York.

1914.	1915.
Burr Winson. John A. Giles.	Delegates not yet appointed.

Boston, Massachusetts.

1914.	1915.
None appointed.	Delegates not yet appointed.

Buffalo, New York.

1914.

George H. Norton.
C. E. P. Babcock.
J. A. Vandewater.
Carl L. Howell.

Chicago, Ill.

1914.	1915.
None appointed.	Delegates not yet appointed.

Columbus, Ohio.

1914.	1915.
None appointed.	Delegates not yet appointed.

Fulton, New York.

1914.	1915.
F. H. Rumsey. G. Clayton Hill.	Delegates not yet appointed.

Joplin, Missouri.

1915.

J. B. Hodgdon.

Kalamazoo, Michigan.

1914.	1915.
A. Lenderink. C. L. Miller. M. E. McMartin.	A. Lenderink.

Kansas City, Missouri.

1914.	1915.
Robert L. Gregory. E. J. McDonnell. Curtis Hill. Clark R. Mandigo.	Curtis Hill.

Little Rock, Arkansas.

1914.	1915.
Henry Levinson. Fred Lund. D. A. McCrea.	Delegates not yet appointed.

Louisville, Kentucky.

1915.

D. R. Lyman.

Lynchburg, Virginia.

1914.

H. L. Shaner.

1915.

H. L. Shaner.

Memphis, Tennessee.

1914.

George C. Lowe.
J. H. Weatherford.
C. C. Pashby.
D. C. Miller.

Minneapolis, Minnesota.

1914.

F. W. Cappelen.
P. B. Walker.
George V. Ziemer.
Ellis R. Dutton.

1915.

F. W. Cappelen.
Ellis R. Dutton.
D. C. Bow.
E. J. Sweeney.

New Haven, Connecticut.

1914.

Max Adler.
W. Scott Eames.
Frederick L. Ford.
Cassius W. Kelly.

1915.

Delegates not yet appointed.

New Orleans, Louisiana.

1914.

Edward E. LaFaye.
Harold W. Newman
W. B. Thompson.
W. J. Hardee.
Wm. Allen.

1915.

Delegates not yet appointed.

New York City, New York.

1914.

Nelson P. Lewis.
George W. Tillson.
E. J. Fort.
R. H. Gillespie.

1915.

R. A. McGregor.
H. H. Schmidt.
Felix Kleeberg.
S. C. Thompson.

Norfolk, Virginia.

1914.

None appointed.

1915.

Delegates not yet appointed.

Omaha, Nebraska.

1914.

Thomas McGovern.
Watson Townsend.
Joseph B. Hammel.
A. C. Kugel.

1915.

Delegates not yet appointed.

Index to Advertisements

Pasco, Washington.

1914.	1915.
None appointed.	Delegates not yet appointed.

Philadelphia, Pennsylvania.

1914.	1915.
George S. Webster. Carleton E. Davis. William H. Connell. William D. Uhler.	Delegates not yet appointed.

Pittsburgh, Pennsylvania.

1914.	1915.
George W. Burke. E. E. Lampher. C. M. Reppert. J. D. Strain.	Charles A. Finley. John F. O'Toole. George W. Burke. N. S. Sprague.

St. Louis, Missouri.

1914.	1915.
Walter L. Hempelmann. Nelson Cunliff. Montgomery Schuyler.	Delegates not yet appointed.

Salisbury, North Carolina.

1914.	1915.
J. E. Ramsey.	Delegates not yet appointed.

Salt Lake City, Utah.

1914.	1915.
Sylvester Q. Cannon.	Sylvester Q. Cannon.

South Omaha, Nebraska.

1914.	1915.
None appointed.	Delegates not yet appointed.

St. Johns, Newfoundland.

	1915.
	John L. Slattery.

Toledo, Ohio.

1914.	1915.
A. W. Boardman. Herbert McKechnie. Thomas A. Taylor. G. A. Gessner.	Delegates not yet appointed.

Toronto, Ontario.

1914.	1915.
R. C. Harris.	R. C. Harris.

Troy, Ohio.

1914.	1915.
M. A. Gantz.	M. A. Gantz.

ASSOCIATE.

Adams, Arthur A., Contractor, Rep. Adams & Ruxbon Construction Co., Springfield, Mass.

ADAMS & RUXBON CONSTRUCTION CO., Springfield, Mass.
Arthur A. Adams, Rep., Springfield, Mass.

Adams, Carl F., Asphalt Specialist, Union Oil Company of California, Mills Bldg., San Francisco, Cal.

AMERICAN CITY, THE, 93 Nassau St., New York City.
Harold S. Buttenheim, Editor, 93 Nassau St., New York City.

AMERICAN TAR CO., THE, 201 Devonshire St., Boston, Mass., Box 3705.
Charles P. Price, Manager, 201 Devonshire St., Boston, Mass.

Armstrong, Alexander F., Rep. Atlantic Refining Co., 3144 Passyunk Ave., Philadelphia, Pa.

ASSOCIATION OF AMERICAN PORTLAND CEMENT MANUFACTURERS, THE, 1526 Land Title Bldg., Philadelphia, Pa.
George W. Myers, Road Engineer, 399 East 19th Ave., Columbus, O.
J. B. Marcellus, 1526 Land Title Bldg., Philadelphia, Pa.

ATLANTIC BITULITHIC COMPANY, 1126-1129 Mutual Bldg., Richmond, Va.
George O. Tenney, President, 1126-1129 Mutual Bldg., Richmond, Va.

ATLANTIC REFINING COMPANY, 3144 Passyunk Ave., Philadelphia, Pa.
A. F. Armstrong, 3144 Passyunk Ave., Philadelphia, Pa.

ATLAS PORTLAND CEMENT COMPANY, THE, 30 Broad St., New York City.
Wilbur T. Challar, Manager Road Department, 30 Broad St., New York City.

BAKER, JOHN, JR., 17 Battery Place, New York City.
John Baker, Jr., 9 So. La Salle St., Chicago, Ill.
Wm. H. Kershaw, 17 Battery Place, New York City.
Dennis A. Kennedy, Boston Manager, 701 Tremont Bldg., Boston, Mass.
Walter L. Hempelmann, 5141 Drexel Ave., Chicago, Ill.

Baker, John, Jr, Rep. John Baker, Jr., 9 La Salle St., Chicago, Ill.

Baker, W. D., Rep. Warner-Quinlan Asphalt Co., 79 Wall St., New York City.

BARBER ASPHALT PAVING COMPANY, THE, Land Title Bldg, Philadelphia, Pa.
Clifford Richardson, 233 Broadway, New York City.
C. N. Forrest, of The New York Testing Laboratory, Maurer, N. J.

Barbour, J. G., Secretary, Metropolitan Paving Brick Co., Canton, Ohio.

BARRETT MANUFACTURING COMPANY, 17 Battery Place, New York City.
Robert W. Pond, Manager Boston Road Department, 35 Wendell St., Boston, Mass.
M. J. Beistle, Columbus, Ohio.
Edward C. Sargent, Cleveland, Ohio.

Beistle, M. J., Rep. Barrett Manufacturing Co., Columbus, Ohio.

Bell, Philip, Manager Road Oil Department, Magnolia Petroleum Co., Box 1671, Dallas, Tex.

BESSEMER LIMESTONE COMPANY, Youngstown, Ohio.

Blackburn, W. T., Consulting Engineer, Dunn Wire-Cut-Lug Brick Co., Paris, Ill.

BLACKMER & POST PIPE COMPANY, St. Louis, Mo.

Blair, Will P., Corresponding Secretary, National Paving Brick Manufacturers' Assn., 824-826 Brotherhood of Locomotive Engineers' Bldg., Cleveland, Ohio.

BOSTON ROMAN ROAD COMPANY, 6 Beacon St., Boston, Mass.
William J. Clark, 6 Beacon St., Boston, Mass.

Briddell, York, Rep. Georgia Engineering Co., Clearwater, Fla.

Brooks, B. F., Engineer, International Clay Products Bureau, 204 New York Life Bldg., Kansas City, Mo.

Bruff, Albert C., District Manager Edison Portland Cement Co., Quincy, Mass.
BUFFALO STEAM ROLLER COMPANY, Box 990, Buffalo, N. Y.
 Jeffers F. Richardson, Sales Manager, Box 990, Buffalo, N. Y.
Burns, Bob., Assistant Sales Manager, Iola Portland Cement Co., 3120 San Jacinto, Dallas, Tex.
Buttenheim, Harold S., Editor, The American City, 98 Nassau St., New York City.

CALIFORNIA BRICK COMPANY, Decoto, Cal.
 Claud E. Fuller, General Manager, Decoto, Cal.
 L. R. McKenzie, Sales Manager, 632 Phelan Bldg., San Francisco, Cal.
Challar, Wilbur T., Manager Road Department, Atlas Portland Cement Co., 30 Broad St., New York City.
Clark, William J., Boston Roman Road Co., 6 Beacon St., Boston, Mass.
Collier, Henry L., Atlanta, Ga.
CREOSOTED WOOD PAVING BLOCK BUREAU, Chicago, Ill.
Crossett, Frederick M., President and Manager Wern Stone Paving Co., 55 Liberty St., New York City.
Curless, Will A., Rep. Thomas-Hammond Machinery Co., 520 Central Bldg., Los Angeles, Cal.
Cutter, Frank G., Vice-Prest., Warren Brothers Co., 1349 Otis Bldg., Chicago, Ill.

Dalzelle, S. J., Rep., Prudential Oil Corporation, Baltimore, Md.
DECKMAN-DUTY BRICK CO., Swetland Bldg., Cleveland, Ohio.
 Spencer M. Duty, President, Swetland Bldg., Cleveland, Ohio.
Dixon, W. W., Rep. Union Clay Products Co., New Brunswick, N. J.
Doane, S. E., Rep. National Lamp Works, 4411 Hough Ave., Cleveland, O.
D'Olier, William L., Chief Engineer, The Sanitation Company, 1538 Girard Ave., Philadelphia, Pa.
Droney, J. R., Sales Manager, United States Asphalt Refining Co., 90 West St., New York City.
Dunn, Frank B., Secretary, Dunn Wire-Cut-Lug Brick Co., Conneaut, O.
DUNN WIRE-CUT-LUG BRICK COMPANY, Conneaut, Ohio.
 Frank B. Dunn, Secretary, Conneaut, Ohio.
 W. C. Perkins, Chief Engineer, Niagara Falls, N. Y.
 F. T. Townsend, Assistant Engineer, 490 Norwood Ave., Buffalo, N. Y.
 W. F. Blackburn, Consulting Engineer, Paris, Ill.
Duty, Spencer M., President The Deckman-Duty Brick Co., Swetland Bldg., Cleveland, Ohio.

EDISON PORTLAND CEMENT COMPANY, 79 Milk St., Boston, Mass.
 Albert C. Bruff, District Manager, Quincy, Mass.
EQUITABLE ASPHALT MAINTENANCE COMPANY, THE, Commerce Bldg., Kansas City, Mo.
 Ford H. Moore, Secretary and Treasurer, Commerce Bldg., Kansas City, Mo.
 James M. Moore, Commerce Bldg., Kansas City, Mo.

Farr, Leslie B., President Harlem Contracting Co., 2 Rector St., New York City.
Fay, Frank T., Road Oil Department, Sales Agent, Standard Oil Company of New York, 50 Congress St., Boston, Mass.
Fisher, Henry, Manager Standard Oil Company, of New York, 26 Broadway, New York City.
Forrest, C. N., Rep. The Barber Asphalt Paving Company, of New York Testing Laboratory, Maurer, N. J.
Fuller, Claud E., Manager California Brick Company, Decoto, Cal.

Fulweiler, W. H., Chemist, The United States Gas Improvement Company Laboratory, 1706 N. Broad St., Philadelphia, Pa.

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A. E. Rudd, Secretary and Treasurer, 143 Cambridge St., Guelph, Ontario, Canada.
GENERAL PETROLEUM COMPANY, San Francisco, Cal.
GEORGIA ENGINEERING COMPANY, Clearwater, Fla.
York Briddell, Clearwater, Fla.
Gilligan, Hugh J., Contractor, 138 First St., Newark, N. J.
Gillum, H. J., Pierce Oil Corporation, 5610 Michigan Ave., Chicago, Ill.
Granger, B. F., Sales Manager, Lock-Joint Pipe Company, Jackson, Mich.

HARLEM CONTRACTING COMPANY, 2 Rector St., New York City.
Leslie B. Farr, President, 2 Rector St., New York City.
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H. V. Hildreth, General Manager, 31 State St., Boston, Mass.
Hildreth, H. V., General Manager Hildreth Granite Company, 31 State St., Boston, Mass.
Hirsh, Allan M., Treasurer, Lock-Joint Pipe Company, 165 Broadway, New York City.
Horn, J. Merrick, Rep. Warren Brothers Company, Ford Bldg., Wilmington, Del.
Horton, D. C., Jacksboro, Tex.
Hull, John A., Rep. Warren Chemical & Manufacturing Co., 17 Battery Place, New York City.
HUNT, ROBERT W. & COMPANY, 2200 Insurance Exchange, Chicago, Ill.
H. H. Morgan, Manager Chicago Cement and Physical Testing Departments, 2200 Insurance Exchange, Chicago, Ill.
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Ingram, G. M., Vice-President Warren Brothers Company, 59 Temple Place, Boston, Mass.
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B. F. Brooks, 204 N. Y. Life Bldg., Kansas City, Mo.
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Bob Burns, Assistant Sales Manager, 3120 San Jacinto, Dallas, Tex.

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JENNISON-WRIGHT COMPANY, 313-315 Huron St., Toledo, Ohio.
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Johnson, Alfred H., President, Texas Bitulithic Company, Praetorian Bldg., Dallas, Tex.

Kaull, Pardon S., Rep. Warren Brothers Company, Railway Exchange Bldg., St. Louis, Mo.
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King, Charles Bayard, Rep. C. F. King & Company, 716 Ford Bldg., Wilmington, Del.

KING, C. F. & COMPANY, 716 Ford Bldg., Wilmington, Del.
Charles Bayard King, 716 Ford Bldg., Wilmington, Del.

Kinney, William M., Inspecting Engineer, Universal Portland Cement Company, 208 S. La Salle St., Chicago, Ill.

Lamson, George W., Mexican and California Asphalts, Railway Exchange Bldg., Chicago, Ill.

Lane, Arthur S., Treasurer, John S. Lane & Son., Inc., Meriden, Conn.
Treasurer, Connecticut Quarries Co.
Treasurer, The Lane Construction Co.

LANE, JOHN S. & SON, Inc., Meriden, Conn.
Arthur S. Lane, Treasurer, Meriden, Conn.

Levering, William A., President, Standard Asphalt & Rubber Company, 137 S. La Salle St., Chicago, Ill.

Lewis, F. J., President, F. J. Lewis Manufacturing Company, 2500 S. Robey St., Chicago, Ill.

LEWIS, F. J., MANUFACTURING COMPANY, 2500 S. Robey St., Chicago, Ill.
F. J. Lewis, President, 2500 S. Robey St., Chicago, Ill.

Lindsay, Gordon I., Rep. Robeson Process Company, 18 East 41st St., New York City.

LOCK JOINT PIPE COMPANY, 165 Broadway, New York City
Coleman Meriwether, President, 165 Broadway, New York City.
Allan M. Hirsh, Treasurer, 165 Broadway, New York City.
B. F Granger, Sales Manager, Jackson, Mich.

Loud, Henry S., Chief Engineer, United States Wood Preserving Co., Morristown, N. J.

MAGNOLIA PETROLEUM COMPANY, Box 1671, Dallas, Tex.
Philip Bell, Manager Road Oil Dept., Box 1671, Dallas, Tex.

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McAvoy, John C., Secretary and General Manager, McAvoy Vitrified Brick Company, Broad and Arch Sts., Philadelphia, Pa.

McAVOY VITRIFIED BRICK COMPANY, Broad and Arch Sts., Philadelphia, Pa.
John McAvoy, Secretary and General Manager, Broad and Arch Sts., Philadelphia, Pa.

McGrath, George B., Southern Sales Manager, The United States Asphalt Refining Company, Citizens Bank Bldg., Norfolk, Va.

McKenzie, L. R., Sales Manager, California Brick Company, 632 Phelan Bldg., San Francisco, Cal.

Meriwether, Coleman, President, Lock-Joint Pipe Company, 165 Broadway, New York City.

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J. G. Barbour, Secretary, Canton, Ohio.

Miner, H. A., President, Steel Protected Concrete Co., Trust Bldg., Philadelphia, Pa.

Moore, Ford H., General Manager, The Equitable Asphalt Maintenance Company, Commerce Bldg., Kansas City, Mo.

Moore, James M., Rep. The Equitable Asphalt Maintenance Company, Commerce Bldg., Kansas City, Mo.

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OCKANDER BROTHERS, Hillsboro, Tex.
Frank Whitley, Hillsboro, Tex.
OKLAHOMA GLAZED CEMENT PIPE COMPANY, THE, Tulsa, Okla.
G. N. Wright, President, Tulsa, Okla.

PARMLEY, WALTER C., Everett Bldg., Union Square, New York City.
PEEBLES PAVING BRICK COMPANY, Portsmouth, Ohio.
F. L. Manning, Sales Manager, Portsmouth, Ohio.
Perkins, G. Howard, Superintendent of Refineries, Warren Brothers Company, 59 Temple Place, Boston, Mass.
Perkins, W. C., Chief Engineer, Dunn Wire-Cut-Lug Brick Company, Niagara Falls, N. Y.
PIERCE OIL CORPORATION, St. Louis, Mo.
H. J. Gillum, 5610 Michigan Ave., Chicago, Ill.
PITTSBURGH FILTER MANUFACTURING COMPANY, Farmers Bank Bldg., Pittsburgh, Pa.
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POWER SPECIALTY COMPANY, 111 Broadway, New York City.
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S. J. Dalzelle, Box 1013, Baltimore, Md.

Reed, Alexander, Rep. United States Wood Preserving Company, 165 Broadway, New York City.
Reilly, P. C., President, Republic Creosoting Company, Merchants Bank Bldg., Indianapolis, Ind.
REPUBLIC CREOSOTING COMPANY, Merchants Bank Bldg., Indianapolis, Ind.
P. C. Reilly, President, Merchants Bank Bldg., Indianapolis, Ind.
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Richardson, Jeffers F., Sales Manager, Buffalo Steam Roller Company, Box 990, Buffalo, N. Y.
RIDLON, FRANK, Co., 158 Summer St., Boston, Mass.
James J. M. Smith, Salesman, 158 Summer St., Boston, Mass.
ROBESON PROCESS COMPANY, 18 E. 41st St., New York City.
Gordon I. Lindsay, 18 E. 41st St., New York City.
Robinson, E. M., Rep. Warren Brothers Company, 59 Temple Place, Boston, Mass.
Rudd, A. E., Secretary-Treasurer, General Construction Company, 143 Cambridge St., Guelph, Ontario, Canada.

ST. MARYS SEWER PIPE COMPANY, St. Marys, Pa.
Sanders, R. W., Rep. Prudential Oil Corporation, New York City.

SANITATION CORPORATION, THE, 50 Church St., New York City.
William L. D'Olier, Chief Engineer, 1533 Girard Ave., Philadelphia, Pa.
Sargent, Edward C., Rep. Barrett Manufacturing Company, Cleveland, Ohio.
Schutte, August E., Consulting Chemist, Warren Brothers Company, 59 Temple Place, Boston, Mass.
Smith, James J. M., Salesman, Frank Ridlon Co., 158 Summer St., Boston, Bass.
Smith, W. Stuart, District Manager, Warren Brothers Company, 49 West Ave., Rochester, N. Y.
Spencer, W. B., Rep. Continental Construction Company, 2 Rector St., New York City.
STANDARD ASPHALT & RUBBER COMPANY, 208 S. La Salle St., Chicago, Ill.
William A. Levering, President, 208 S. La Salle St., Chicago, Ill.
STANDARD BITULITHIC COMPANY, 50 Church St., New York City.
R. W. Turner, President, 50 Church St., New York City.
STANDARD OIL COMPANY OF NEW JERSEY, 26 Broadway, New York City.
STANDARD OIL COMPANY OF NEW YORK, 26 Broadway, New York City.
Frank T. Fay, Sales Agent, Road Oil Department, 50 Congress St., Boston, Mass.
Henry Fisher, Manager, 26 Broadway, New York City.
STEEL PROTECTED CONCRETE COMPANY, Trust Bldg., Philadelphia, Pa.
H. A. Miner, President, Trust Bldg., Philadelphia, Pa.
Stevens, George M., Salesman, 6 Beacon St., Boston, Mass.
Strother, O. G., Rep. United States Wood Preserving Company, 1017 N. Front St., Harrisburg, Pa.

Tenney, George O., Vice-President, Warren Brothers Company, 1108 Virginia Railway & Power Bldg., Richmond, Va.
TEXAS BITULITHIC COMPANY, Praetorian Bldg., Dallas, Tex.
Alfred H. Johnson, President, Praetorian Bldg., Dallas, Tex.
TEXAS COMPANY, THE, Houston, Tex., and 17 Battery Place, New York City.
THOMAS-HAMMOND MACHINERY COMPANY, 5-7 St. Paul Ave., Tacoma, Wash.
Will A. Curless, 520 Central Bldg., Los Angeles, Cal.
Thurston, George W., Secretary, The Western Paving Brick Manufacturers' Association, 416 Dwight Bldg., Kansas City, Mo.
Townsend, F. T., Assistant Engineer, Dunn Wire-Cut-Lug Brick Company, 490 Norwood Ave., Buffalo, N. Y.
Turner, R. W., Vice-President, Warren Brothers Company, 50 Church St., New York City.

UNION CLAY PRODUCTS COMPANY, New Brunswick, N. J.
Wl. W. Dixon, New Brunswick, N. J.
UNION OIL COMPANY OF CALIFORNIA, Mills Bldg., San Francisco, Cal.
Carl Frederick Adam, Asphalt Specialist, Mills Bldg., San Francisco, Cal.
UNITED GAS IMPROVEMENT COMPANY, THE, 1706 N. Broad St., Philadelphia, Pa.
W. H. Fulweiler, Chemist, 1706 N. Broad St., Philadelphia, Pa.
UNITED STATES ASPHALT & REFINING COMPANY, THE, 90 West St., New York City.
J. R. Draney, Sales Manager, 90 West St., New York City.
George B. McGrath, Southern Sales Manager, Citizens Bank Bldg., Norfolk, Va.

UNITED STATES WOOD PRESERVING COMPANY, THE, 165 Broadway, New York City.
Alexander Reed, 165 Broadway, New York City.
Henry S. Loud, Chief Engineer, Morristown, N. J.
O. G. Strother, Pennsylvania Representative, 1017 N. Front St., Harrisburg, Pa.

UNIVERSAL PORTLAND CEMENT COMPANY, 208 S. La Salle St., Chicago, Ill.
William M. Kinney, Inspecting Engineer, 208 S. La Salle St., Chicago, Ill.

WARNER-QUINLAN ASPHALT COMPANY, 79 Wall St., New York City.
W. D. Baker, 79 Wall St., New York City.

WARREN BROTHERS COMPANY, 59 Temple Place, Boston, Mass.
George C. Warren, President, 59 Temple Place, Boston, Mass.
James M. Head, Attorney, 59 Temple Place, Boston, Mass.
Ralph L. Warren, 59 Temple Place, Boston, Mass.
August E. Schutte, Consulting Chemist, 59 Temple Place, Boston, Mass.
G. Howard Perkins, Superintendent of Refineries, 59 Temple Place, Boston, Mass.
Frank G. Cutter, 1349 Otis Bldg., Chicago, Ill.
J. Merrick Horn, Ford Bldg., Wilmington, Del.
W. Stuart Smith, 49 West Ave., Rochester, N. Y.
George O. Tenney, Richmond, Va.
Pardon S. Kaull, Railway Exchange Building, St. Louis, Mo.
G. M. Ingram, 59 Temple Place, Boston, Mass.
E. M. Robinson, 59 Temple Place, Boston, Mass.
R. W. Turner, 50 Church St., New York City.

Warren, George C., President, Warren Brothers Company, 59 Temple Place, Boston, Mass.

Warren, Ralph L., Rep. Warren Brothers Company, 59 Temple Place, Boston, Mass.

WARREN CHEMICAL & MANUFACTURING COMPANY, 17 Battery Place, New York City.
John A. Hull, 17 Battery Place, New York City.

WERN MACHINERY & ENGINEERING COMPANY, 30 Church St., New York City.
Sir Gust. Pers. Wern, President, 30 Church St., New York City.

Wern, Sir Gust. Pers., President, Wern Machinery & Engineering Company, 30 Church St., New York City.

WERN STONE PAVING COMPANY, 55 Liberty St., New York City.
Frederick M. Crossett, President and Manager, 55 Liberty St., New York City.

WESTERN PAVING BRICK MANUFACTURERS' ASSN., 416 Dwight Bldg., Kansas City, Mo.
George W. Thurston, Secretary, 416 Dwight Bldg., Kansas City, Mo.

Whitley, Frank, Rep. Ockander Brothers, Hillsboro, Tex.

Wright, G. N., President, Oklahoma Glazed Cement Pipe Co., Tulsa, Okla.

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GEOGRAPHICAL LIST OF MEMBERS.

ALABAMA—
Birmingham—Active: Wallace L. Caldwell, Julian Kendrick, Walter G. Kirkpatrick, R. E. Mead, B. B. Meriwether, Maury Nicholson; Tuscaloosa—Active: Walter H. Nicol.

ARKANSAS—
Fort Smith—Active: Merle H. Reed; Helena—Active: Louis R. Parmelee; Little Rock—Active: Hugh R. Carter, Edgar A. Kingsley, Henry Levinson. Municipal Delegates for 1915 not yet appointed; Affiliated: O. J. Griffith; Paragould—Active: Robert Stallings; Pine Bluff—Active: F. R. Allen, Wm. J. Parker.

CALIFORNIA—
Decoto—Associate: *Claude E. Fuller*, California Brick Co.; Los Angeles—Active: E. F. Scattergood; Associate: *Will A. Curless;* Modesto—Active: George H. Freitas; Pasadena—Active: T. D. Allin, C. W. Koiner, Maurice G. Parsons, Wm. Thum; Sacramento—Active: Austin B. Fletcher; San Diego—Active: Wm. C. Hale, Jr.; San Francisco—Associate. *Carl F. Adams*, Union Oil Co. of California, *L. R. McKenzie*, General Petroleum Co.; Santa Barbara—Active: E. A. Garland.

CONNECTICUT—
Hartford—Active: Chas. J. Bennett, Geo. A. Parker, Leon F. Peck; Meriden—Associate: *Arthur S. Lane*, John S. Lane & Son; New Haven—Active Jas. H. MacDonald. Municipal Delegates for 1915 not yet appointed.

COLORADO—
Denver—Active: A. Lincoln Fellows.

DISTRICT OF COLUMBIA—
Washington—Active: Prevost Hubbard.

DELAWARE—
Wilmington—Active: L. V. Christy, W. J. Horrigan, M. D. Murphy, Chas. A. Rudolph, Geo. W. Sparks, Alexander J. Taylor, James Wilson; Associate: *J. Merrick Horn, Charles Bayard King*, C. F. King Co.

FLORIDA—
Bartow—Active: A. J. Hawkins; Clearwater—Active: H. E. Anschutz; Associate: *York Briddell*, Georgia Engineering Co.; Jacksonville—Active: John E. Ballinger, Geo. B. Hills, L. D. Smoot; Miami—Active: B. H. Klyce, H. A. Naberhuis.

GEORGIA—
Albany—Active: R. J. Edgerly; Atlanta—Active: J. C. Cook. Associate: *Henry L. Collier*. Augusta—Active: Nisbet Wingfield; Columbus—Active: W. C. Campbell; Savannah—Active: Elbridge R. Conant; Valdosta—Active: W. H. Gainey.

ILLINOIS—
Chicago—Active: J. W. Alvord, John B. Hittell, Lester Kirschbraun, Maurice N. Lovewell, Ernest McCullough, Victor Nicholson, Robert I. Rudolph, H. S. Richards, Isaac Van Trump, Linn White. Municipal Delegates for 1915 not yet appointed. Associate: *John Baker, Jr.*, Creosoted Wood Block Paving Bureau, *Frank G. Cutter, H. J. Gillum, W. L. Hempelmann*, Universal Portland Cement Co., *Geo. W. Lamson, Wm. A. Levering*, Standard Asphalt & Rubber Co., *F. J. Lewis*, F. J. Lewis Mfg. Co., *H. H. Morgan;* Moline—Active: Clark G. Anderson, Lyle Payton; Paris—Associate: *W. T. Blackburn;* Urbana—Active: Paul Hansen, A. N. Talbot; Waukegan—Active: M. J. Douthit.

INDIANA—
Elkhart—Active: L. M. Russell; Indianapolis—Active: Charles C. Brown, Harry W. Klausmann; Associate: *P. C. Reilly,* Republic Creosoting Co.; Richmond—Active: Frederick R. Charles; Salem—Active: John C. Prow.

IOWA—
Creston—Active: Theodore S. De Lay; Davenport—Active: Allen R. Boudinot; Fort Madison—Active: R. J. Lewis; Grinnell—Active: John F. Mangold; Sioux City—Active: Keyes C. Gaynor.

KANSAS—
Atchison—Active: S. K. McCrary; Columbus—Active: C. M. Cooper; Emporia—Active: Matthew Brown; Lawrence—Active: Holland Wheeler, Manhattan—Active: O. E. Noble; Pittsburg—Active: Lawrence E. Curfman; Topeka—Active: Alexander R. Young.

KENTUCKY—
Louisville—Municipal: David R. Lyman; Owensboro—Active: H. M. Talbott.

LOUISIANA—
Lake Charles—Active: Frederick H. Frankland, Fred Giddings, E. L. Gorham; New Orleans—Active: George C. Earl, Wm. von Phul. Affiliated: L. C. Datz. Municipal Delegates for 1915 not yet appointed.

MAINE—
Bangor—Active: Philip H. Coombs.

MARYLAND—
Baltimore—Active: Walter W. Crosby, John C. Little, James W. Ogier. Municipal: H. K. McCay, R. Keith Compton, R. M. Cooksey. Associate: *S. J. Dalzelle;* Salisbury—Active: P. S. Shockley.

MASSACHUSETTS—
Beverly—Active: Harrie L. Whitney; Boston—Active: Joshua Atwood, Frank A. Barbour, Edgar S. Dorr, Harrison P. Eddy, Alexander L. Kidd, Franklin M. Miner, Louis K. Rourke, Wm. J. C. Semple, Wm. D. Sohier, James H. Sullivan, Robert S. Weston. Affiliated: John Campbell. Municipal Delegates for 1915 not yet appointed. Associate: *Charles P. Price,* American Tar Co., *Dennis A. Kennedy, Robert W. Pond, Wm. J. Clark,* Boston Roman Road Co., Edison Portland Cement Co., *Frank T. Fay, H. V. Hildreth,* Hildreth Granite Co., *James G. M. Ingram, G. Howard Perkins, E. M. Robinson, August E. Schuette, George C. Warren, Ralph L. Warren,* Warren Brothers Co.; Brookline—Active: Michael Driscoll, Frederick L. Olmstead; Cambridge—Active: Hector J. Hughes, Edward W. Quinn, George C. Whipple; Concord—Active: John M. Keyes; New Bedford—Active: Charles S. Ashley; Pittsfield—Active: Ralph W. Emerson, Arthur B. Farnham; Quincy—Associate: *Albert C. Bruff;* South Yarmouth—Active: Charles H. Davis; Springfield—Active: Frederick H. Clark. Associate: *A. A. Adams,* Adams & Ruxbon Construction Co.; Winchester—Artive: Arthur W. Dean.

MICHIGAN—
Ann Arbor—Active: Manley Osgood; Detroit—Active: John C. McCabe; Grand Rapids—Active: Edward H. Christ, L. D. Cutcheon, L. E. Stevens; Jackson—Associate: *B. F. Granger;* Kalamazoo—Municipal: A. Lenderink; Lansing—Active: Edward D. Rich.

MINNESOTA—
East Grand Forks—Active: J. J. Smith; Minneapolis—Municipal: F. W. Capellen, Ellis R. Dutton, D. C. Bow, E. J. Sweeney; St. Paul—Active: August Hohenstein.

MISSISSIPPI—

Jackson—Active: J. R. Bayliss, John Irwin Pierce; Tupelo—Active: N. B. Buchanan.

MISSOURI—

Joplin—Municipal: J. B. Hodgdon; Kansas City—Active: Louis R. Ash. Municipal: Curtis Hill; Associate: *Ford H. Moore, James M. Moore*, Equitable Asphalt Maintenance Co., *George W. Thurston*, Western Paving Brick Manufacturers' Association, *B. F. Brooks*, International Clay Products Bureau; St. Joseph—Active: Carl P. Hoff; St. Louis—Active: Robt. E. McMath. Affiliated: Hermann von Schrenk. Municipal Delegates for 1915 not yet appointed. Associate: Blackmer & Post Pipe Co., *Pardon S. Kaull*, Pierce Oil Corporation.

NEBRASKA—

Omaha—Municipal Delegates for 1915 not yet appointed; South Omaha—Municipal Delegates for 1915 not yet appointed.

NEW HAMPSHIRE—

Berlin—Active: L. J. Wertheim; Concord—Active: Will B. Howe; Franklin—Active: Gilbert Hodges.

NEW JERSEY—

Asbury Park—Active: Niart Rogers; Atlantic City—Active: John W. Hackney; East Orange—Active: Wm. D. Willigerod; Elizabeth—Active: W. H. Luster; Jersey City—Active: Thomas J. Wasser; Maurer—Associate: *C. N. Forrest;* Morristown—Associate: *Henry S. Loud;* Newark—Active: Harland Bartholomew, Albert H. Bierteumpfel, Wm. M. Brown, A. R. Denman, Charles P. Gillen, James C. Hallock, Jacob Haussling, Wm. A. Howell, C. F. Kraemer, James Owen, E. S. Rankin, Frederick A. Reimer, A. M. Reynolds, Morris R. Sherrerd, Charles M. Shipman. Affiliated: George A. Sawin. Associate: *Hugh J. Gilligan;* Nutley—Active: Frank T. Shepard; Phillipsburg—Active: Robert P. Howell; Plainfield—Active: Andrew J. Gavett; Rutherford—Active: Robert M. Watson; South Orange—Active: Edmund R. Halsey; Trenton—Active: Alfred C. Gregory, Harry F. Harris, Anastasius Parobek; Upper Montclaim—Active: John M. Goodell.

NEW YORK—

Albany—Active: Horace Andrews, Wallace Greenalch, Frank R. Lanagan; Auburn—Active: J. Walter Ackerman; Binghamton—Active: John A. Giles. Municipal Delegates for 1915 not yet appointed; Broadalbin—Active: Wm. P. Judson; Brooklyn—Active: George Berry, E. J. Fort, George T. Hammond, Joseph Strachan, George W. Tillson; Buffalo—Associate: *Jeffers F. Richardson*, Buffalo Steam Roller Co., *F. T. Townsend;* Elmira—Active: Thurber A. Brown; Fulton—Municipal Delegates for 1915 not yet appointed; Hudson—Active: M. J. O'Hara; Ithaca—Active: Henry N. Ogden; Kingston—Active: Edward B. Codwise; New Brunswick—Associate: *W. W. Dixon*, Union Clay Products Co.; New York—Active: A. H. Blanchard, Irving C. Bull, A. W. Dow, Henry B. Drowne, John T. Fetherston, A. Prescott Folwell, George W. Fuller, Richard H. Gillespie, P. W. Henry, Rudolph Hering, Nicholas S. Hill, Jr., J. W. Howard, Nelson P. Lewis, Charles A. Mullen, Clarence D. Pollock, Alexander Potter, A. J. Provost, Robert Ridgway, Francis P. Smith, Louis L. Tribus. Affiliated: J. W. DuB Gould. Municipal: Felix Kleeberg, R. A. McGregor, H. H. Schmidt, S. C. Thompson. Associate: *Harold S. Buttenheim*, The American City, *Wilbur T. Challar*, Atlas Portland Cement Co., John Baker, Jr., *Clifford Richardson*, Barrett Manufacturing Co., *Frederick M. Crossett*, Wern Stone Paving Co., *J. R. Droney*,

U. S. Asphalt & Refining Co., *Leslie B. Farr*, Harlem Contracting Co., *Henry Fisher*, Standard Oil Co. of New York. *Allan M. Hirsch*, *Coleman Meriwether*, Lock Joint Pipe Co., *Wm. H. Kershaw*, The Texas Co., *Gordon I. Lindsay*, Robeson Process Co., *Walter Parmley*, Power Specialty Co., *R. W. Sanders*, Prudential Oil Corporation, *Alexander Reed*, The Sanitation Corporation, *R. W. Turner*, Standard Oil Co. of New Jersey, *W. D. Baker*, Warner-Quinlan Asphalt Co., *John A. Hull*, Warren Chemical & Manufacturing Co., *Sir Gust Pers Wern*, Wern Machinery & Engineering Co.; Niagara Falls—Associate: *W. C. Perkins;* Port Richmond—Active: Wm. R. Hillyer; Poughkeepsie—Active: Albert W. Sylvester; Rochester—Active: F. T. Elwood, E. A. Fisher, Herbert W. Pierce. Associate: *W. Stuart Smith;* Saranac Lake—Active: John L. Collins; Yonkers—Active: D. F. Fulton.

NORTH CAROLINA—

Asheville—Active: B. M. Lee; Charlotte—Active: Frank P. Drane, Joseph Firth; Salisbury—Municipal Delegates for 1915 not yet appointed; Winston—Active: John M. Ambler.

NORTH DAKOTA—

Grand Forks—Active—H. G. Lykken.

OHIO—

Canton—Associate: *J. G. Barbour*, Metropolitan Paving Brick Co.; Cincinnati—Active: August Herrmann; Cleveland—Active: Robert Hoffman. Associate: *Edward C. Sargent, W. P. Blair*, National Paving Brick Manufacturers' Association, *Spencer M. Duty*, Deckman-Duty Brick Co., *S. E. Doane*, National Lamp Works; Columbus—Active: Thomas H. Brannan, Henry Maetzel. Municipal Delegates for 1915 not yet appointed. Associate: *George W. Myers, M. J. Beistle;* Conneaut—Associate: *Frank B. Dunn*, Dunn Wire-Cut-Lug Brick Co.; Dayton—Active: James E. Barlow, Frederick J. Cellarius, H. M. Waite; Portsmouth—Associate: *F. L. Manning*, Peebles Paving Brick Co.; Toledo—Active: G. A. Crayton. Municipal Delegates for 1915 not yet appointed. Associate: *H. G. Jennison*, Jennison-Wright Co.; Troy—Municipal: M. A. Gantz; Youngstown—Associate: Bessemer Limestone Co.

OKLAHOMA—

Chickasha—Active: Elmer E. Colby; Durant—Active: W. P. Danford; McAlester—Active: A. H. Kendrick; Muskogee—Active: E. F. Peterson; Tulsa—Active: T. C. Hughes. Associate: *G. N. Wright*, The Oklahoma Glazed Cement Pipe Co.

OREGON—

Portland—Active: John C. Sharp.

PENNSYLVANIA—

Allentown—Active: Earle W. Meckley; Erie—Active: B. E. Briggs, F. G. Lynch, L. V. Metz; Farrell—Active: J. Fred Thomas; Greenville—Active: Ray Vosler; Harrisburg—Associate: *O. G. Strother;* Indiana—Active: Thomas Pealer; Johnstown—Active: Clark P. Collins, Dudley T. Corning; Meadville—Active: B. F. Miller, Jr.; Norristown—Active: S. Cameron Corson; Philadelphia—Municipal: Four Delegates to be appointed. Associate: *J. B. Marcellus*, Association of Portland Cement Manufacturers, Barber Asphalt Paving Co., *Wm. L. D'Olier, W. H. Fulweiler*, United Gas & Improvement Co., *John C. McAvoy*, McAvoy Vitrified Brick Co., *H. A. Miner*, Steel-Protected Concrete Co., *A. F. Armstrong*, Atlantic Refining Co.; Pittsburgh—Active: Leo Hudson, Charles M. Reppert, John D. Stevenson, Charles F. Taylor, H. H. Craver. Affiliated: Wm. Slifer. Municipal: Charles

A. Finley, John F. O'Toole, George W. Burke, N. S. Sprague. Associate: Pittsburgh Filter Manufacturing Co.; Reading—Active: Edmund B. Ulrich; St. Marys—Associate: St. Marys Sewer Pipe Co.; Wilkes-Barre—Active: B. K. Finch.

RHODE ISLAND—
Pawtucket—Active: George A. Carpenter; Woonsocket—Affiliated: G. W. Lothrop.

SOUTH CAROLINA—
Charleston—Active: James H. Dingle; Columbia—Active: John McNeal, Gadsden E. Shand, W. L. Tomlinson.

SOUTH DAKOTA—
Lead—Active—Lucien D. Lea.

TENNESSEE—
Knoxville—Active: John W. Flenniken, J. B. McCalla; Memphis—Active: J. H. Weatherford.

TEXAS—
Abilene—Active: H. J. Bradshaw; Amarillo—Active: R. O. Whyman; Austin—Active: George S. Iredell, M. C. Welborn; College Station—Active—Roger L. Morrison; Dallas—Active: E. L. Dalton, M. C. Erwin, W. S. Hammett, J. E. Lewis, J. M. Preston, Joe B. Wills. Affiliated: W. H. Norman. Associate: *Phillip Bell*, Magnolia Petroleum Co., *Bob Burns*, Iola Portland Cement Co., *Alfred H. Johnson*, Texas Bitulithic Co., Fort Worth—Active: John B. Hawley, Frank J. Van Zuben; Galveston—Active: A. T. Dickey; Greenville—Active: Allen D. Duck; Hillsboro—Associate: *Frank Whitley*, Ockander Bros.; Houston—Active: Edward E. Sands. Affiliated: D. A. Hegarty. Associate: The Texas Co.; Jackson—Associate: *D. C. Horton;* Paris—Active: J. W. Crook; San Antonio—Active: Frank V. P. Ellsworth, J. J. Goodfellow.

UTAH—
Salt Lake City—Active: George D. Keyser, George W. Riter. Municipal Delegates for 1915 not yet appointed.

VIRGINIA—
Danville—Active: J. O. Magruder; Lynchburg—Active: H. L. Shaner. Municipal Delegates for 1915 not yet appointed; Norfolk—Active: Robert E. Steed. Municipal Delegates for 1915 not yet appointed. Associate: *George B. McGrath;* Richmond—Associate: *George O. Tenney.*

WASHINGTON—
Pasco—Municipal Delegates for 1915 not yet appointed; Spokane—Active: Morton Macartney; Tacoma—Associate: Thomas-Hammond Machinery Co.

WEST VIRGINIA—
Morgantown—Active: Robert D. Hennen.

WISCONSIN—
Beloit—Active: G. E. Heebink; Madison—Affiliated: Clyde H. Teesdale; Milwaukee—Active: George H. Benzenberg, T. Chalkley Hatton, J. A. Messiroff; Waukesha—Active: Morgan R. Butler.

CANADA——ALBERTA—
Calgary—Active: George W. Craig, James Wilson; West Calgary—Active: W. H. R. Gardiner; Lethbridge—Active: Wm. A. Adam.

BRITISH COLUMBIA—
Victoria—Active: Charles H. Rust.

MANITOBA—
Winnipeg—Active: Wm. Aldrich, A. C. D. Blanchard, H. N. Ruttan.

NEWFOUNDLAND—
St. Johns—Municipal: J. L. Slattery.

ONTARIO—
Guelph—Associate: *A. E. Rudd,* General Construction Co.; Hamilton—Active: W. C. Brennan, Andrew F. Macallum; Toronto—Municipal: R. C. Harris.

QUEBEC—
Montreal—Active: John R. Barlow, Alcide Chausse, Arthur Parent, Frederick A. Snyder. Associate: *W. H. Mussens,* Mussens, Ltd.; Quebec—Active: W. D. Baillairge.

CHINA—
Hangchow, Chekiang—Active: Henry E. Baker.

CONVENTIONS OF THE SOCIETY

First Annual Convention..................1894......Buffalo, N. Y.
Second Annual Convention................1895......Cincinnati, Ohio.
Third Annual Convention ....1896......Chicago, Ill.
Fourth Annual Convention................1897......Nashville, Tenn.
Fifth Annual Convention..................1898......Washington, D. C.
Sixth Annual Convention ....1899......Toronto, Canada.
Seventh Annual Convention...............1900......Milwaukee, Wis.
Eighth Annual Convention................1901......Niagara Falls, N. Y.
Ninth Annual Convention.................1902......Rochester, N. Y.
Tenth Annual Convention.................1903......Indianapolis, Ind.
Eleventh Annual Convention..............1904......St. Louis, Mo.
Twelfth Annual Convention...............1905......Montreal, Canada.
Thirteenth Annual Convention............1906......Birmingham, Ala.
Fourteenth Annual Convention..... .....1907......Detroit, Mich.
Fifteenth Annual Convention..............1908......Atlantic City, N. J.
Sixteenth Annual Convention.............1909......Little Rock, Ark.
Seventeenth Annual Convention..........1910......Erie, Pa.
Eighteenth Annual Convention............1911......Grand Rapids, Mich
Nineteenth Annual Convention............1912......Dallas, Texas.
Twentieth Annual Convention.............1913......Wilmington, Del.
Twenty-first Annual Convention..........1914......Boston, Mass.
Twenty-second Annual Convention........1915......Dayton, Ohio.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS

SPECIFICATIONS FOR BITULITHIC PAVEMENT ON ANY APPROVED FORM OF FOUNDATION

WEARING SURFACE

On the foundation prepared as hereinabove specified, shall be laid the Bitulithic Wearing Surface and Seal Coat, described below, so as to have a thickness of two inches (2″) after thorough compression. The Wearing Surface shall be composed of hard, crushed stone, sand, and Bitulithic Cement.

The Bitulithic Cement herein specified, besides being produced under the direction, processes, supervision and laboratory inspection of and with ingredients approved by Warren Brothers Company, shall, in all respects, comply with the specifications for asphalt cement contained in the sheet asphalt specifications of the American Society of Municipal Improvements.

Either of the two following methods and apparatus shall be used in the preparation of the wearing surface.

1. The stone and sand shall be heated in a rotary drier and while still hot, separated into the desired number of different sizes by means of a rotary screen having a minimum screen opening of about 1-10 of an inch and a maximum opening of about one and one-half (1½) inch. The openings in the successive screen sections up to one-half (½) inch size shall not vary more than one-fourth of an inch (¼″) and not more than three-quarters of an inch (¾″) for the sizes larger than one-half inch (½″). The aggregate thus separated shall pass into a bin having sections or compartments corresponding to the screen sections. From these compartments the aggregate shall pass into a weigh box, resting on a multi-beam scale. The desired amount of aggregate from

each of the above compartments shall be accurately weighed separately on the scale and the batch dropped into a "twin pug" mixer, where it shall be intimately associated and thoroughly commingled with a predetermined quantity of Bitulithic Cement sufficient to coat all particles of the aggregate and to fill the voids in same.

2. The stone and sand shall first be carefully measured as to sizes and a definite quantity of each size shall then be fed into an elevator terminating in a hopper or bin which discharges into a rotary drier or heater, both hopper and heater being so designed as to keep each batch by itself until heated. From the rotary heater the batch of mineral aggregate shall pass into a rotary cylindrical mixer containing blades, spirals or other devices for producing a uniform mixture of the mineral aggregate with a predetermined quantity of the Bitulithic Cement sufficient to coat all the particles of the aggregate and to fill the voids in same.

The different sized particles of stone and sand ranging in size from impalpable powder to about one-half the thickness of the wearing surface shall be combined in such proportions as to secure in the mineral aggregate density, or low percentage of voids, and inherent stability or resistance to displacement, producing an aggregate which when combined with the Bitulithic Cement and laid in place and compacted will form a street paving structure consisting of mineral aggregate of different sizes and the Bitulithic Cement which permeates the entire mass, fills the voids and unites the various particles thereof. If the crushed stone and sand do not contain enough finely divided particles or impalpable powder to produce a low percentage of voids in the aggregate the deficiency shall be made up by the addition of any other suitable fine mineral matter.

The mixture and ingredients thereof shall be maintained at a temperature consistent with good workmanship. The mixture when reaching the street shall be hot enough to allow of being

easily spread and raked and shall not be so hot as to injure the Bitulithic Cement.

Surface Finish or Seal Coat

There shall be spread over the Bitulithic surface mixture a seal coat, using per square yard of Bitulithic pavement approximately one-fourth (¼) gallon of Bitulithic Cement, into which shall be incorporated approximately twenty-five (25) pounds of mineral aggregate not larger than one-quarter (¼) inch diameter. After spreading the seal coat, it shall be thoroughly rolled into the Bitulithic surface mixture. On grades a coarser aggregate may be used.

General

Each layer of the work shall be kept as free as possible from dirt, so that it will unite with the succeeding layer.

The bituminous composition or cement shall in each case be free from water, and shall be especially refined to remove volatile and other matter susceptible to atmospheric influences.

Warren Brothers Company, owner of the patents used in the construction of the Bitulithic Pavement, shall file with the proper official or board which is about to receive bids for the work, a properly executed binding agreement to furnish to any contractor desiring to bid for the work all the necessary Bitulithic Surface material, mixed ready for use, and Bitulithic Cement, and the sand, gravel, or stone screenings for the surface finish course, in accordance with Sections, "Wearing Surface" and "Surface Finish," at a definite reasonable price per square yard. Said price shall include a license to use all of the patents required in the construction of the Bitulithic Pavement as herein specified.

The acceptance of bids by .... and the letting of a contract for the same shall be deemed by Warren Brothers Company to be an acceptance of its proposal by

....

and by the Contractor to whom such contract shall be awarded, and are all that shall be necessary to bind Warren Brothers Company to said agreement. The filing of a bid under these specifications will be construed as an acceptance of the terms of the license agreement filed by the Warren Brothers Company, at the price fixed in said agreement which is on file with the proper official or board.

The foregoing is a correct and complete copy of specifications for Bitulithic Pavement as adopted by the American Society of Municipal Improvements, at its twenty-second annual convention held at Dayton, Ohio, October 12th to 15th, inclusive, in the year of 1915, as one of the standard types of pavement specifications of the said society.

CHARLES C. BROWN, *Secretary*,
American Society of
Municipal Improvements.

"MODIFIED TOPEKA" SPECIFICATIONS

As adopted by the American Society of Municipal Improvements at its 22nd Annual Convention held at Dayton, Ohio, October 12th–15th, 1915.

Under statement of Warren Brothers Company that it does not infringe its patents, being a modification of the "Original Topeka" specifications which Warren Brothers Company never claimed to be an infringement.

A.S.M.I. 1915 CONVENTION
"MODIFIED" TOPEKA
SPECIFICATIONS

Bitumen		7 to 9 %
Mineral Aggregate	Passing 200 mesh screen	7 to 10 %
	" 80 " "	10 to 20 %
	" 40 " "	10 to 25 %
	" 20 " "	10 to 25 %
	" 8 " "	10 to 20 %
	" 4 " "	15 to 20 %
	" 2 (=½″) "	5 to 10 %

In adopting the Topeka Specifications as one of its standards, the Association for Standardizing Paving Specifications (now merged with the American Society of Municipal Improvements) at its Fourth and last Annual Convention held at Pittsburgh, February 24th–28th, 1913, recommended that a "*binder course should be laid as called for under the standard specifications for sheet asphalt pavement,*" which read as follows (Page 66 of 1913 A. S. P. S. Convention Report):

"BINDER STONE

Stone or gravel to be used for asphaltic concrete binder shall be hard and durable, free from all foreign substances, and of uniformly varying sizes, from one inch down.

Binder Course

"Asphaltic concrete binder shall be made as follows: The binder stone and sand as above specified shall be heated to from 200 to 325 degrees Fahr. in suitable appliances. Stone and sand shall be measured off separately and then be mixed, with sufficient asphaltic cement prepared as heretofore specified, in such proportions that the resulting aggregate will contain by weight material passing a No. 10-mesh screen, between 25 and 35 per cent., and bitumen in quantity from 5 to 8 per cent. of the entire mixture. Binder thus prepared shall be a compact mass containing a minimum of voids. With the permission of (proper city officials) when available, old asphaltic surface paving mixtures may be used in combination with the binder stone, such mixtures having been previously crushed or disintegrated and augmented with at least 1 per cent. of fresh asphaltic cement, so that when combined, the resulting binder shall form an equally compact mass and correspond as to aggregate passing a No. 10-mesh screen and its contained percentages of bitumen with the requirements for the mixture previously specified.

"Note. Inasmuch as the percentage of bitumen in the binder will depend upon the grading of the aggregate, the proportion of the materials used in the above may be varied by (authorized city official) but only within the limits designated.

Laying Binder Course

"The asphaltic concrete binder shall be brought to the work in wagons covered with canvas or other suitable material, and upon reaching the street shall have a temperature of 200 to 325 degrees Fahr. It shall be placed upon the street and raked to a uniform surface to such depth that, after being rolled and thoroughly compacted, it shall have an average thickness of.............. inches. The surface, after compression, shall show at no place an excess of asphaltic cement, and any spot covering an area of one square foot or more showing an excess of asphaltic cement, shall be cut out and replaced with other material. Smaller spots may be dried by the use of stone dust and smoothers. Any asphaltic concrete binder broken up during the process of laying must be removed and replaced with new material. No more binder shall be laid at any one time than can be covered by two days' run of the paving plant on surface mixture."

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